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Constituting Interaction and Phenomena in Geological Practice:

A study in the interactive organization of talk, bodies, and phenomenal landscapes and their
public revealing as consequential worlds in geological fieldwork

A dissertation submitted in partial satisfaction of the
requirements for the degree Doctor of Philosophy
in Applied Linguistics

by

Michael Sean Smith

2018

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2018

ABSTRACT OF THE DISSERTATION

Constituting Interaction and Phenomena in Scientific Practice:

A study in the interactive organization of talk, bodies, and phenomenal landscapes and their
public revealing as consequential worlds in geological fieldwork

by

Michael Sean Smith

Doctor of Philosophy in Applied Linguistics

University of California, Los Angeles, 2018

Professor Charles Goodwin, Chair

The present research analyzes interactants as they work and interact within naturally occurring, heterogenous landscapes in wilderness settings. The analytical focus is on how interactants cultivate understandings about a) the landscapes within which they are currently interacting and b) the locales and/or objects situated therein, and importantly, how these landscapes, objects, locales are integrated in the practitioner's embodied and discursive practices as interactional, sequential, and turn-constructive resources and achievements. In the end, the analysis illustrate how the participants' interactional practices reveal a consequential, knowable world. Using field geology as a perspicuous settings, this study will investigate these practices in the work that field geologists produce in constructing geological objects and locales in the form of rocks, layers,

faults, folds, locales, and landscapes, and how these are the product of the participants' coordination between talk-in-interaction and other modalities, including gesture, embodied action, mobility, and visual forms of representation. The findings will contribute to our understanding of other domains of scientific practice, e.g., how language, embodied action, and diagrammatic reasoning facilitate scientific pursuits. The study involves observing both novice and senior practitioners work in wilderness settings. Analyses will focus on how practitioners' knowledge is acquired, deployed, and transformed in interaction not only with one another but in engagement with the dense materiality of their phenomenal world, and how the products of these interactions and engagement contribute to discourse in the geosciences as a community of practice and body of knowledge.

The dissertation of Michael Sean Smith is approved.

John H. Schumann

Federica Raia

John Heritage

Marjorie Harness Goodwin

Charles Goodwin, Committee Chair

University of California, Los Angeles

2018

Dedication

This dissertation is dedicated to Chuck Goodwin, my mentor and friend. This work represents another trek in our journey through the many spaces that I shared with you and others—through the wilderness with Dave and Darrell, and Matty, Basil, Zack, and all of the wonderful people who joined us along the way. This work represents another turn in the many conversations we have had together, with one another and with others in your lab—whether in analyzing data or discussing ideas. Along the way, so many people have come across the world to join us in your lab—to many to list here. They came for you of course and I’m thankful to you for sharing those experience. This work represents another step in our walks together whether in Owens Valley, Paleto Folds, or in Mammoth. I’ll never forget those walks, listening to you, and you being utterly fascinated with the rich complexity of the world around us and the people within it. I will never lose that deep sense of curiosity and fascination. In so many ways, I continue to walk with even as I sat alone writing. You and your guidance have never left my side and your presence moves through this work, not just in the words on the page, but the spaces in between—a presence that is thoroughly alive and uncompromised in its brilliance and passion. I am so thankful for you, your time, your love for Candy, your endless love for so many people. You given a voice to me and so many others. I find that voice faltering now though in expressing just exactly how much you mean to me. I can only say thank you—thank you so very much Chuck.

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Biographic Sketch

Michael Sean Smith is a graduate from the Department of Applied Linguistics at the University of California, Los Angeles. His research investigates how participants coordinate interaction and build actions, as these are situated, not only in complex settings, alongside tools and other materials, but how they situated with regard to the courses of activity that participants pursue in their collaborative work. His work has investigated professional practice in a range of settings, from the work in a heart biopsy unit to the work by geologists in open, unstructured wilderness settings. Integral to these contexts are the situated learning of novice and senior practitioners and endogenous pedagogy that facilitates this work. His dissertation focuses on the interactional and embodied practices used by field geologists in advancing their practical and professional work.

Introduction

This dissertation investigates the interactional, linguistic, and embodied practices that actors use while working and interacting in open, complex wilderness settings. The dissertation investigates three domains of practice:

- 1) This dissertation investigates what I describe as diagrammatic gestures, that is, the various gestural, graphic, and material practices that practitioners use for depicting, perceiving, and documenting complex geological features, phenomena, and processes in the landscape. I argue that when used as an interpretive tool, these depictions constitute a form of diagrammatic reasoning.
- 2) The second set of interactional practices that I investigated here are those that participants use for making relevant features in the co-present setting so as to make them observable, assessable, and actionable to others particularly in regard to the participants' ongoing courses of action. I argue that these 'noticings' become actionable not primarily in their composition or in providing a clearly recognizable 'first' action; rather they work first, by directing recipients' attention to co-present features in the current setting that in turn make relevant the tasks, activities, and collaborative projects that co-participants' pursue. The responses they engender as such are not so much selected for by the prior turn in isolation, but rather emerge as occasioned—through the prior talk, but more fundamentally through what is taken to be putatively recognizable in the co-present feature being invoked. The significance of the analysis is in demonstrating practitioners' orientation towards the temporal progression of the activities in which they inhabit.
- 3) Lastly, I investigated how through endogenous pedagogical practices that we see

4) emerge in the field, through which practitioners are socialized into the various reasoning practices integral to geologic practice. As I argued, practitioners routinely orient to different classes of knowables in their explanations: One class is comprised of statements about what is observable and evidentially grounded in the landscape versus those statements that are more normic in orientation. These are comprised of statements about what is not observable but taken to be given in the geological process being investigated.

This study focuses on the face-to-face interaction between novice and senior geologists conducting fieldwork, typically in unstructured, heterogeneous, wilderness settings. Using field geology as a perspicuous setting, I examine how the practices described above facilitate the practical and professional work of the collaborative work that interactants pursue in field geology--as a scientific endeavor--for perceiving, documenting, and reconstructing geological phenomena and processes, as well as synthesizing those into the literary and graphic materials that animate discourse in the geosciences as a community of practice and body of knowledge. The analysis of the field geologists' interactions and collaborative work advances our understanding on the range, composition, and organization of interactional practices, their situated use, and the role they play in structuring and facilitating the participants' professional work.

The outline of this dissertation is as follows: Using field geology as perspicuous setting, I investigate 1) field geologists' use of gestural and/or graphic renderings, e.g., field-sketches, line-drawings, etc., for investigating geological phenomena in the landscape. As I argue, the practice do more than just depict phenomena; rather they provide field geologists the opportunity to superimpose tentative 'working hypotheses' onto the physical world and test those in an iterative, public, and thus dialogical manner. In contrast to previous studies in

gesture, I argue that the complexity of the phenomena and the analytical use of the rendering practices requires a more complex model for understanding their use and interpretation and in this regard I propose that the gestural/graphic renderings function analytical tools only in so far as they accomplish diagrammatic reasoning.

I next investigate 2) participants' use of a class of practices where some "observable" is formulated so as to make available for co-participants as a "noticeable," "assessable," "reportable," or otherwise actionable object for participants to operate on in the subsequent talk. I argue that this actionability is in part constituted via the relevancy of the observable to the ongoing activities or settings within which the field geologists are currently operating, and as such, provides interactants a means for situating how 'what-we're-doing now' is embedded within larger activities and projects.

Finally I examine the field geologists' coordinated movement through large, uneven landscapes, and analyze how practitioners organize mobility as a resource and achievement not only the sequential organization of talk-in-interaction and/or embodied action but as an investigatory tool in the field geologists' investigation of phenomenal landscapes. This includes an analysis of a) practitioners' mobility is integrated into the embodied and linguistic construction of turns at talk, an analysis of b) how space and spatial features are made meaningful through their incorporation in participants' mobile practices, and c) how different mobile practices underpin intersubjectivity in face-to-face interaction and ongoing courses of activity.

In the section below, I introduce the reader to geological reasoning in general, field geology in particular, and introduce the reader to the institutional goals, reasoning practices and recurrent analytical problems for practitioners in field geology.

Geological reasoning, especially that seen in field geology, emerges from first, the

particular empirical demands given in the discipline as well as its objects of interest, and second, the plurality of approaches that have been brought to bear on investigating the problems presented in those objects.

Hull (1976) identifies geology as one of the four main historical sciences (among cosmology, paleontology, and human history). Accordingly, geological explanation, especially of the sort used in the field, differs from the experimental sciences primarily in its reliance on historical explanation as a means for advancing discovery. Indeed, much of geological work, especially in the field, does not work towards making or testing predictions. There exists two more or less connected motives for this fact: one is related to the larger institutional goals found in field geology; the other is the result of the epistemology that arises from the nature of geological data.

The landscapes and geological structures that exist today are the result of the unique histories that contributed to their existence. Geologists primarily operate with the objective of describing and making explanations relevant to the description of the geological "individual" (e.g., a specific outcrop, the Colorado Plateau, the Grand Tetons, etc.), understanding its 'life' history, and detail the casual circumstances that led to its becoming "an identifiable and discrete 'individual'" (Frodeman, 1995, p. 966). This goal can be contrasted against sciences like physics or chemistry which are essentially ahistorical, meaning that "the particularities of place and time play no significant role in the reasoning process" outside their initial conditions (Frodeman, 1995, p. 964). So while geology uses explanatory models common to experimental sciences (namely, the deductive-nomological model of explanation), explanatory practices, including generalization, prediction, etc., are not employed often in geology, nor are they all that relevant to its larger operational goals. Instead, "[t]he goal of geology is the derivation and testing of singular descriptive statements about the past" (Kitts,

1976, p. 38) that place geological events in a hypothesized temporal order (Kitts, 1963). Accordingly, geology "...is not at all concerned with the confirmation or denial of any theory; but it is deeply concerned with the accurate recital of the events of the earth's history" (Kitts, 1963, p. 299). This focus on historical explanation, in turn, necessitates distinct differences in the reasoning practices that it and its practitioners use for accomplishing this.

The nature of the individual--everything that contributes to its identity--necessarily interacts with the concepts that the geologist bring within that place and how he or she interprets phenomena within. This is not all that different from how a physician, for example, makes a diagnosis: He or she takes into account not only the symptoms that the patient exhibits, the biomedical models that may pertain (which may be more or less invariant across individuals); the physician also takes into account the patient's particular life history (e.g., trauma, diet, negative habits, possible exposure to pathogens, etc.). Like medicine, while the geologist may draw on knowledge and methods from physics or chemistry that are more or less thought invariant across circumstances, in order for him or her to accomplish geological description, he or she is nonetheless faced with the task of explaining of how a particular combination of events led to the individual's current state. Accordingly, when surveying geological literature and discussions in the field, it becomes apparent that "retrodiction, not prediction, is the most characteristic geological inference." (Kitts, 1976, p. 38)

Retrodiction presents its own empirical problems, primarily in how events in the past are inferred: While the geologist may "see" past events in the landscape, it is easy to forget that "...the propositions with which historical inferences begin are not themselves historical but are instead assertions about the present" (Kitts, 1976, p. 38). Conflating the two becomes problematic where the onlooker confuses the mechanics of a given geological process with its preservation or lack thereof in the geological record. Herein lies "the principle of the

asymmetry of recordability: reliable indicators of interacting systems permit only retrocognitive inferences concerning the interactions *for which they vouch* but no predictive inferences to the corresponding later interactions" (Grunbaum, 1963, p. 283, cited in Kitts, 1976, p. 42, emphasis mine). Basically, the inferences that retrodictions rely on can only be made about the presence of traces that "vouch" for a given system; they cannot, however, be used such that the absence of a trace necessarily means that the system did not occur. The present, however, provides an incomplete picture of the past: Most geological processes are not directly observable as they occur over too great of a time. Evidence of past events tends to be erased through time. Consequently, the geological record is rarely preserved, resulting in large gaps in the stratigraphic record and incomplete data. Geological explanations in turn, both in publications and in the interactions observed in this data, always orient to the possibility of "boundary conditions," i.e, the conditions that cannot be accounted for in an explanation (Kitts, 1976, p. 32). Even in the absence of boundary conditions, we nevertheless see a 'disciplined skepticism' on the geologist's part: "Geologists are apparently more inclined to suppose that the same antecedents have different consequences than to suppose the contrary. A geologist will maintain that it is not really true that different initial conditions may result in indistinguishable subsequent states, it only seems to be true." (Kitts, 1976, p. 43).

Due in large part to these institutional goals, empirical conditions in fieldwork, and the general epistemological outlook that emerge from these, we see geologists in the field employ a number of interactional, inscription, and reasoning practices for investigating geological phenomena. We see this in both their use as well as their instruction. Drawing on discussion of Robert Frodeman's discussion on general philosophical issues in geological reasoning and practice, I will outline below the general reasoning practices used in field geology.

Frodeman (1995) portrays geological reasoning as an essentially hermeneutic or

interpretive approach, similar to the methods applied to interpreting texts, suggesting that a landscape, like a text, can be interpreted as a system of signs, whose deeper meanings must be iteratively deciphered via investigation. Drawing on Heidegger, he argues that that *all* human understanding is essentially circular: in order to understand a given phenomena, the meaning of parts emerge from their relationship to the whole, while the whole is emerges from understanding of its parts, or as Frodeman puts it in geological terms: "our understanding of an outcrop is based on our understanding of the individual beds, which are in turn made sense of in terms of their relationship to the entire outcrop" (ibid, p. 963). At the same time, the outcrop onto itself typically means nothing to the "uninitiated" until a geologist instructs him or her on how to first 'see' the rock" (1995, p. 963). This circularity does not preclude geologists from accurately describing geological phenomena, nor does it stop them from comparing competing descriptions. While a geologist's perception of an object is influenced via the tools and concepts he or she brings into the field, that perception is not solely determined by these--"objects assert their own independence" (ibid, p. 963) as Frodeman states succinctly.

Iteration is fundamental to this process, fundamental to geological reasoning as a whole, and replete throughout the excerpts analyzed in this dissertation: While the geologist relies on the initial conception of an object as criteria for making sense of it, the provisional interpretation that emerges are questioned when they conflict with the "...details in the object (or text) that do not jibe with [its] overall conception...[forcing]...us to revise our interpretation of the whole as well...other particulars." (Frodeman, 1995, p. 163). Our understanding deepens further the longer these iterations persist, and within each cycle, our understanding of the whole effects the meanings conditioned by its parts which in turn reveals new understandings of the whole. Narrative plays a crucial role in geological practice.

Frodeman, emphasizes Ricoeur's (1985) argument that narrative is one of the most basic way humans have for constituting experience and making sense of it: "Scientific explanation is based on narrative in the sense that, through telling a story, we create a context that defines and gives meaning to our research and data" (ibid, p. 966). Narratives in turn advance understandings by forcing the details of an event into generalizations but by integrating it within a meaningful temporal sequence.

Because historical explanation is so integral to field geology as a mode of investigation, retrodictions and narrative become fundamental as explanatory practices in advancing its aims. Many of the assertions made in geology, both in the field and larger discourse, are more *normic* in nature, than they are generalizations or probabilistic statements. This is an important distinction to keep in mind when analyzing assertions--whether in written discourse or the turns-at-talk and embodied actions in this data: while many assertions found in geological discourse (as well as interaction in the field) look to be probabilistic, employing qualifications like "tends to" or "probably," they are not deployed nor interpreted as making claims about the frequency of their asserted events.¹ In contrast to the probabilistic assertions, the (un)certainly projected in a normic assertion applies to the entire scope of the assertion, as specified by the geologist, *except for those conditions where special conditions may apply* (Scriven 1959a in Kitts, 1976). While they do not specify what special conditions may invalidate the claim, their phrasing and qualification makes an appeal to keeping that possibility in mind and do so primarily by operating on the judgement of their reader (or recipient) as members of the same community of practice. Kitts (1976) argues that their particular formulations provide for their "widest applicability" and are, moreover, useful

¹ Of course, probabilistic statements do appear in statements where the geologists estimate distances, size, or relative amounts (Raab & Brosch, 1996).

"...where the system of exceptions, although perfectly comprehensible in the sense that one can learn how to judge their relevance, is exceedingly complex" (ibid, p. 37). Importantly, for the story being told about geological practice here, and for the analyses that this dissertation pursues in the subsequent chapters, (un)certainty does not emerge as a function of the probability formulated in the talk and otherwise; neither does it emerge as a deficiency in the practitioners' current understanding; rather (un)certainty emerges as a fundamental epistemic stance taken by the practitioners analyzed here and, moreover, a way of knowing that they contribute in addition to whatever they can explicitly assert about a given object of analysis. Moreover, while these practices range in their of "the geologist engages in the hermeneutic and perceptual aspects of geological work largely on the pre-reflexive level, i.e., they are not aware of them." (Raab & Frodeman, 2002, p. 68+3)

The provisional nature of observation in field geology is not a statement about the nature of geological knowledge in general. It is rather a statement of how knowledge is applied in the field and the implications that this has for the epistemic, evidential stances that we see practitioners project in the data. The interactional practices analyzed in this dissertation, though interactive, linguistic, material and/or embodied in form and shape, are all essentially reasoning practices, where geological reasoning is (re)constituted in publicly and interactively mediated form.

Geology differs from work conducted in laboratory settings. Most theorizing about scientific practice, however, has been heavily biased towards that common to laboratory settings. In line with this, Latour & Woolgar discuss inscriptions largely within the context of technology, i.e., "inscription machines" (ibid, 1979). Many STK studies have occluded the real presence of human bodies in many of these studies

In contrast to laboratory settings, field geologists work in highly heterogeneous,

unstructured, wilderness environments. Finding and cataloging the materials, observations, and measurements necessary for animating discourse in the field requires first, a practitioner going into the field, walking through unfolding landscapes, and perceiving phenomena out of the dense, undifferentiated materiality of the natural world, and recording that phenomena according to the practices afforded her by the geosciences as a community of practice and body of knowledge. The geologist's body becomes the first inscription-device available to the practitioner in geologic work. In moving through a landscape, noting locations where observations can and cannot be made, her body and its movement marks the first point through which geological structures emerge and are rendered knowable. The body and especially mobility in interaction and geologic practice becomes one of the first domains of geologic fieldwork where this study can inform our understanding of embodied action and mobility in co-present interaction and scientific practice. This description is not an outside analytic imposition but something readily noted by members as well. Here are the words of one student geologist who makes an observation after he and his group have been examining a rock outcrop:



Figure 1a: Geology students analyzing a rock outcrop

Daryl: It's looks like we're seeing an S1 and an S2 though.
It looks like it has, but then when you actually look at the
rock, you don't see any internal structure.
(pause)

Daryl: But it's visible when you walk up, which is kind of puzzling.

For the student the outcrop as a perceptual object changes as he walks towards it. This 'forest-for-the-trees' is a perceptual process experienced field geologists regularly encounter in the field. As such movement becomes both an analytical tool for the practitioner and a resource for co-participants in coordinating interaction in the field. For Ingold (2004, p. 330) any analysis of the body in motion begins with the feet and walking, arguing that it is through our contact with the ground "...that we are most fundamentally and continually 'in touch' with our surroundings," and through our movement the ground "...against which things 'stand out' as foci of attention...[emerges as]...a focus in itself." Locomotion it would seem precedes and makes possible perceptual activity, as the geologist walks through visually investigating the landscape, different forms emerge in the horizon. James Gibson, founder of ecological psychology, argues regarding visual perception, that "...the forms of the objects we see are

specified by transformations in the pattern of reflected light reaching our eyes as we move about in their vicinity. We perceive, in short, not from a fixed point but...[from]...a 'path of observation', a continuous itinerary of movement (Gibson, 1979: 195–7 cited in Ingold 2004, p. 331). From the geologists' movement then, geologic structures emerge first from the landscape as "condensations or crystallizations" of mobile activity rather just being forms superimposed on a material substrate (ibid, p. 333). In this manner "walking" and "looking" are interlinked in practice making "locomotion" as necessary a starting point as cognition for analyzing mobile and perceptual activities (ibid, 331).

Arguing in the phenomenological tradition Merleau-Ponty describes the body in motion as the "measurement of the world," a *point of articulation* where the world is joined and/or divided (Merleau-Ponty, 2003, p. 24). In moving through the the landscape, the geologist continuously articulates and re-articulates that landscape before her; what appears as phenomena at one point in time and space is mediated by what appears to the geologist in other points in time and space. Perception then is neither a property of the perceiver nor the landscape, but something that emerges in the interaction between (Carusi and Hoel, 2014, p. 212). As the geologist moves through the landscape; objects in the horizon appear and gain definition for the geologist as she moves towards or around it. While the final determination of the nature of any particular object is made through other analytic activities, it is the geologists' mobility that brings her to locations providing her the opportunity to use these tools.

When searching for outcrops² for instance or surveying large geomorphological structures, how participants move their bodies, what they attend to is always analyzable as to

² Outcrops are visible exposures of bedrock or ancient deposits that are not covered by a mantle of soil and vegetation and thus allow for close examination of geological materials.

whether it is in pursuit of some work-related activity, and this in turn is analyzable to other participants for coordinating multi-part activities and work. "Co-presence" in such a context is a fluid construct with the geologists' coordination and interaction often shifting from focused to unfocused. Long periods of lapsed silence can occur while geologists individually survey the landscape for objects of interest; at the same time their overarching orientation and thus movement and associated is coordinated and typically set on relatively circumscribed destination. More so, this manner of comporting oneself in relation to the environment emerges itself as a historically sedimented, work-attendant activity, with its own practices and inferences for understanding others behavior. As such, facets like involvement, engagement, attention, etc., are continuously judged against a "... backdrop of common expectations against which all upcoming actions can be adjudged." As such, "involvement," that constituting "the purpose or aim" of the participant expressed via his or her embodied engagement provides other participants a resource for noting potentially findings, allowing for points of comparison, and potentially marking the boundaries of 'contacts' between geological bodies. Analysis of the data will shed light on how participants' shifts from silence, periodic "outlouds" about something a geologist sees, to ongoing sequentially-organized talk is coordinated with different kinds of movement, stillness, and the selection of different locales for geological analysis.

A major component of this work, besides the talk, gesture, and technology, consists of 'whole-body movement' in the landscape. Within the last decade, research interactional linguistics has shifted towards examining how interactants manage talk-in-interaction and organize their conduct while in "on the move" in various environments, e.g., urban, rural, and/or wilderness settings. This work, undertaken in a growing number of studies and volumes, falls under the rubric of "mobility" and focuses specifically on how 'whole-body

movement' is coordinated with other modalities in talk-in-interaction or conversely how talk-in-interaction is altered when conducted within mobile activity, and asks a number of questions regarding mobility: What practices do people use for being mobile; what understandings do they display with these practices? How are mobile activities interpolated within sequentially unfolding interaction and vice versa? How do people interact, organize their own mobility and/or coordinate it with the mobility of others; what resources are brought to bear in accomplishing these practical problems--whether they be talk, the body, objects and/or "...features of the material and spatial surround" (Haddington, Mondada, & Nevile, 2013, p. 6)?

If we want to accurately give voice to the contexts in which geologists work, we should also account for how the landscape itself provides for different types of engagement. The landscape and features within it constitute what Latour, following Serres, called "quasi-objects". Quasi-objects are middle-range objects that bridge the natural and social world while not quite being of either. Importantly they "...draw people together in particular relations...[with one another as well as]...into relations with other nonhuman objects (p. 255). "A ball is not an ordinary object, for it is what it is only if a subject holds it. Over there, on the ground, it is nothing; it is stupid; it has no meaning, no function, and no value...The collective game doesn't need persons.... The ball isn't there for the [player]; the exact contrary is true: the [player] is the object of the ball.... It is the subject of the body, subject of bodies, and like a subject of subjects (ibid, p. 225 – 226). Objects, especially those that are associated with distinct forms of knowledge provide a "quasi-agency" that impinges upon us in a manner that cannot be reduced to solely a social construction. As the geologists engage the features and examine rocks, the objects themselves bring co-participants "together in constantly shifting configurations or relations with one another." (ibid). Throughout much of

the data below, we will see the objects provide substrates for participants to co-operate on building subsequent action.

On a more fundamental level, the work presented in dissertation, further advances the position that action in talk-in-interaction, and language more generically, finds use not in their isolated forms in turns-at-talk, gesture, material practices, and other forms of embodiment, but that these co-operate on one another within ongoing courses of action as well as activities and the settings that occasion their use. Moreover, the analysis presented in this dissertation reveals how action and interaction more generically is reflexively built from a phenomenal world that is incrementally revealed as consequential, analyzable, categorical through its systematic inclusion and iterative exposition in embodied action and the sequential organization of talk-in-interaction.

Data & Methods

This data corpus consists of 4 separate video-documented ethnographic visits to field-based projects involving field geologists. The first ethnography was performed by Charles Goodwin over the course of four days in the Summer of 2011 in and around Yellowstone National Park. This fieldwork consisted a Research Experience for Undergraduates (REU) project led by David Mogk (Montana State University) and Darrell Henry (Louisiana State University) that brought advanced undergraduates into the field on an active research study to gain research experience. The study participants consist of the two senior geologists already introduced, a graduate assistant, and 15 advanced undergraduate researchers. While there was a pedagogical aspect to the participants work, where much of the field survey, collection of samples, and daily input were overseen by the senior geologists, the project was nevertheless an active research study and the work and data collected did contribute to publishable findings.

The second ethnography was conducted the author over the course of five days in the Summer of 2014 in the Madison River Valley, Montana. This fieldwork consisted of an undergraduate geology capstone field course that was required of senior students before graduation. The study participants included three instructors, two graduate assistant, and 32 senior undergraduate students. The activities performed in this fieldwork were entirely curriculum based and organized according to different sub-disciplinary modules. The work performed is entirely pedagogical (i.e., resulting in no other product beyond the student's completed assignments). Nevertheless, the students performed much of the work independently of the instructors, and so, provides an insight into how participants approach the work as a practical if not professional task.

The last ethnography was conducted by Charles Goodwin and the author collected over the span of five days each in the Summer of 2014 and 2015 in and around the Owens Valley, California. These materials consist of a National Science Foundation (NSF) funded project, organized by Matty Mookerjee (Sonoma State University, California) and Basil Tikoff (University of Wisconsin, Madison). The project was a multi-part collaboration intended to bring together geo-scientists from different sub-disciplines alongside cyber- and information scientists to develop hardware, software solutions and large-scale database architectures to create, upload, and make available digital data for the field-based geosciences. Each season consisted of the project organizers introduced above, and approximately 30 to 35 participants, including geo-scientists from different sub-disciplines and cyber- and information scientists from both academia and industry. The field component involved the participants staying at the White Mountain Research Center in Owens Valley, California and for four days traveling in groups to various geological points of interest to learn about how geo-scientists use tools, collect and record data, and make inferences about geological phenomena; each evening consisted of a participant led discussion on the topic of technological applications in the field or conceptual issues with designing large-scale databases.

This data presented in this dissertation is comprised of video-documented ethnography. Prior to discussing how data was recorded, analyzed, transcribed, and rendered into visual transcripts, I will detail some of the considerations and choices that were made in video-recording the geologists as they worked in the field.

In each of the ethnographies, I went into the field and accompanied the geologists as they went about their activities, moving through uneven, wilderness terrains, as they collected samples, took measurements, and made notes of geological phenomena. As I followed the geologists, I video-recorded some groups following them with a digital camcorder mounted

on a monopod. In addition, I asked other individuals to wear body-mounted cameras attached to their chests so as to record their work with others. On numerous occasions, I used both recording methods simultaneously. The body-mounted cameras present both advantages and disadvantages for recording naturally-occurring interaction. The most immediate limitation that arises in viewing the videos is the limited visual access it provides to the interaction: The video never shows the participant who is wearing the camera. Moreover, one consistently see the other participants either, unless the 'camera-person' is directly facing them. In contrast, the co-participants will typically stand in an L-arrangement or side-by-side (Kendon, 1990) making all the interactants off-screen. In spite of this limitation, the video collected via the body-mounted presents a unique perspective onto embodied conduct of the wearer, especially their gesture and handling of objects, and their embodied attention towards features in the co-present landscape. In the video recording on the digital camcorder, attempts were made to keep all the relevant participants in the frame as well framing their position or movement with the larger landscape as well as features within that landscape (see Figure 2.1 above for an example).

One of the benefits promised by smaller, more transportable, recording equipment with longer lasting recording times was the ability to follow people into uneven, unstructured settings--settings unlike the those typically investigated in more domestic settings. This benefit is lost, however, when recordings of mobile activity focus only on those instances where participants stop in the landscape. As a result, we lose insight into the mobile practices participants use for coordinating movement through the terrain. Additionally, we lose insight into how decision-making arises in movement guiding parties to ever-evolving destinations. In order to capture these dynamics in their entirety, I decided to continuously record without cuts so as to gain a "micro-longitudinal" perspective onto how participants' situated reasoning

was coordinated with respect to their daily work and longterm projects. This ability to track actions as they

After the data were collected and brought back from the field, the videos were transcribed and analyzed using conversation analysis (Sacks, Schegloff, & Jefferson, 1974) with priority given to participants' use of embodied action and gesture (Goodwin, 2000; 2010; Mondada, 2013). As opposed to more traditional accounts in conversation analysis, especially those focus almost exclusively on talk as the defining feature for formulating action, at the expense of other interactional practices, the account pursued here, following from Charles Goodwin, Marjorie Goodwin & Asta Cekaite, Jürgen Streeck, Lorenza Mondada, and Arnulf Deppermann, attempts to understand how action in talk-in-interaction emerges praxeologically in the ongoing courses of action and activity, and is thus reflexively built from a phenomenal world that is incrementally revealed as consequential, analyzable, categorical through its systematic inclusion and iterative exposition in embodied action and the sequential organization of talk-in-interaction.

Diagrammatic Gestures & Extempore Reasoning as a Public Practice in Geological Fieldwork

Introduction

When interactants perform gestures in the midst of talk, a large part of the observable work accomplished via their situated-use is in representing substantive or propositional meaning of what is being uttered (Kendon, 2017). Gestures of this sort work as "...meaningful substitutions and analogical stand-ins for ideas, objects, actions, relations, etc" (Novack & Goldin-Meadow, 2016, p. 1). They are analyzed either for their form and described as "iconics" and "metaphorics," and thus distinguishable from other manual actions such as deictics, beat gestures, etc (McNeill, 1992, p. 80). Conversely, they are analyzed for their function, where the distinction between iconic and deictic gestures, for instance, collapses, as both manual actions accomplish reference: A speaker can point in a given direction to direct her interlocutor's attention toward some object that she is referring to in her talk; alternatively, she can manually "...make present a physical object or pattern of action, or diagram the relationships between the objects (real or conceptual)" (Kendon, 2018, p. 168). Alternatively, gestures are analyzed for the actions they pursue, as "depictions," for instance, an can appear within an ensemble of different actions, "...including iconic gestures, facial gestures, quotations of all kinds, [and] full-scale demonstrations..." that interactants assemble for *depicting* physical scenes (Clark, 2016, p. 324).

A tacit focus in this perspective is that gestures emerge primarily as the product of a given course of action--which in turn can be psychological and perceptual or interactive in origin. Cooperrider (2018) characterizes this some in his discussion of two traditions in gesture research: One tradition, personified in McNeill's work (1992), analyzes gesture as a "window

into the mind"--what it tell us about a speaker's thoughts--or alternatively treats the gesture as an "unwitting accompaniment" and "byproduct of the design" of speech (Cooperrider, 2018, p. 178). The other approach focuses on the interactive role of gesture as the central phenomena under investigation (Goodwin, 1986, 1994; Streeck, 1996; 2013; Haviland, 1993; 2000; Enfield, 2005; 2009). Gestures are treated here not as mere byproducts of thought or speech, but rather the "products of design" themselves (Cooperrider, 2018, p. 176). Whether analyzed as a interactional practice or for the insight it provides into psychological processes, gesture is treated in both bodies of work as the outcome of a given course of work.

A consequence of this focus is that gestures are generally analyzed in a linear relation with their referents: the gesture either reveals a referent or propositional content as it originates within the gesturer's perception (@tk - growth point), or as it makes visually available in the perception of its intended audience. In both perspective, there exists the propensity to treat the gesture as playing a relatively inert role in this interaction--while it may mediate how interactants perceive a referent, it rarely alters how they perceive it in the first place or alters their understanding of it. The lack of attention to this use is likely due to that in most mundane contexts rarely are interactants uncertain about the meaning they do or will attribute to a referent. Even where the gesture operates directly on a co-present referent--whether highlighting or features of its appearance (Goodwin, 1994; 2007)--as soon as a given feature is revealed via the gesture as an instance of something (i.e., revealing a dark patch of soil as a post hole in an archaeological excavation), rarely does any uncertainty continue as to "what" the gestured object or phenomena is (i.e., its ontological status). Consequently, gestures rarely occasion transformations their users' understanding of the referent past their initial signification. Moreover, in mundane talk, the events, objects, or concepts depicted in

gesture are presupposed to exist or occur exactly as they are finally depicted, even if they are not initially depicted as such. In short, most gestures we see seldom invite close scrutiny of either their form, referents, or the relations between.

Rarer are the instances where gestures, in depicting referents, occasion transformations in how their users perceive those referents, and rarely investigated is how the gestures and other manual depictions thusly play a role in facilitating those transformations. This is particularly relevant in contexts like that investigated in this chapter, field geology, where interactants routinely depict phenomena that for them is under investigation and undergoing change in their perception and understanding. In these settings, we see gesture and other manual depictions continually being positioned as not just the final stage of a given interpretive or interactive process but also as a launching point for subsequent use and re-use in the continuation of that process.

This study examines gestures in contexts where participants in the course of their collaborative work (i.e., field geology) investigate geological phenomena via their depiction in various linguistic, graphical, and gestural practices: e.g., in their verbal/textual description, estimation, classification, and/or potential measurement, recording, quantification, and collection. A significant domain of this work, i.e., recording previously unrecorded geological descriptions, occurs in unstructured, wilderness settings. And while geologists do draw on pre-formulated knowledge and skill-sets for rendering geological phenomena, they are nonetheless faced in each instance with the perceptual, practical, and analytical problem of competently finding, depicting, and understanding these phenomena via text, pictures, measurements, or as the case may be, gesture. As will be revealed in the analysis below, the phenomena studied by field geologists--though being physical co-present in the landscape--is

for the purposes of its perception, analysis, and description, accorded a liminal or transitional status in the geologists' collaborative work. Accordingly, the gestures analyzed here in these contexts function not through the depiction of fully-ascertained objects; rather they function through their depiction of phenomena that are liminal and transitional and continually undergoing iterative reformulation through the analysis. The gestures used in the field will be argued to provide perceptual tools for the participants in analyzing co-present geological structures and thus play an active role in the constitution of the geological structures. As such, diagrammatic gestures cannot be treated as merely re-presentations of a "docile, dormant world that just happened to be there" (Schegloff 2007, p. 87, note 17); rather, what they depict instead provide for how that world becomes observable and meaningful to the geologists in the first instance.

This chapter investigates the situated use of various gestural practices--termed *diagrammatic gestures*--for perceiving, analyzing, and modeling geological phenomena and processes. Though diagrammatic gestures do depict referents, they do so for the purpose of discovering and revealing referents, specifically as geological phenomena. These geological objects in turn take shape in the geologist's perception and understanding even as they are being gesturally diagrammed and are, moreover, demonstrably revealed through the diagram itself. Diagrammatic gestures thus function simultaneously as instrumental actions that "...affect the world by directly interacting with it...[and whose] purpose is...[shaped partly by]...the movement itself" (Novack & Goldin-Meadow, 2016, p. 2) and representational actions where the objects or phenomena that the speaker is using in his discourse are re-presented "as images of various kinds with a metaphorical import" (Kendon, 2018, p. 165). They affect the world and directly interact with it through an iterative re-presentation which

in turn modulates the practitioners' perception and understanding of the object of study. As a result, they facilitate thinking specifically about particulars so as to make them available for "generalization and transfer of knowledge" (ibid, p. 1) and provide means for users to generate knowledge about the world (Koschmann, 2011, 2014; Koschmann & Zemel, 2009). This is as true for the co-participants as whole, as it is for the gesturer him or herself.

While the analysis undertaken here presents a novel use of gesture not adequately explored in prior literature, it necessarily builds from prior work in gesture studies, both in mundane and professional settings. This includes Charles Goodwin's work in environmentally coupled gestures (2007), co-operative action (2013; 2017), Nick Enfield's work in gestural diagrams and cognitive artifacts (2003; 2004; 2005), work on how gesture is used in scientific practice (Becvar, Hollan, & Hutchins, 2008; Jacoby & Gonzales, 1991; Ochs, Gonzales, & Jacoby, 1996; Ochs, Jacoby, & Gonzales, 1994), among others. Moreover, this study speaks to the larger issues in representation in scientific practice and social studies in science in general (Alač, 2006; Fountain, 2008; Garfinkel, Lynch, & Livingston, 1981; Latour, 1986, 1987; Latour & Woolgar, 1986; Lynch, 1985, 1988, 1991; Pickering, 1995; Price, 2003). Rather than using this place for an extended discussion of prior literature, the discussion of the diagrammatic gestures will be better served by beginning with an analysis of the phenomena. Interpolated in my analysis of the excerpts, I will draw connections with the literature mentioned above. I will return to this literature in the discussion and attempt to synthesize it with the findings presented here.

Linework & Diagrammatic Reasoning

In this section I analyze one geologist, Jack's, use of line-drawings for investigating the

folding and faulting evident in a large road-cut.³ While I focus on line-drawings here as opposed to gesture, as the two are manifestations of diagrammatic reasoning, a point of comparison here will inform the analysis of diagrammatic gesture later. Line-drawings provide a useful point of entry for discussing diagrammatic gestures: While graphic diagrams and gestural diagrams would expectedly have different sets of affordances and constraints, their use as diagrammatic practices nevertheless reveal a similar set of features organized around advancing the geologist's work. This discussion will provide us clearer understanding for how diagrammatic reasoning manifests, whether in a sketched diagram or in gesture, and how practitioners then use gesture (alongside other materials) to diagrammatically investigate geological phenomena, test competing hypotheses, and build dynamic models of geological processes. As will become readily apparent throughout the excerpts, the manner in which geologists use gesture for diagrammatic reasoning changes how the gestures are constructed and deployed in the geologists' work.

³ A road-cut is a massive section of a cliff, hill, or mountain has been cut away for the purpose of road or other passage thus exposing relatively unweathered geological structure underneath.

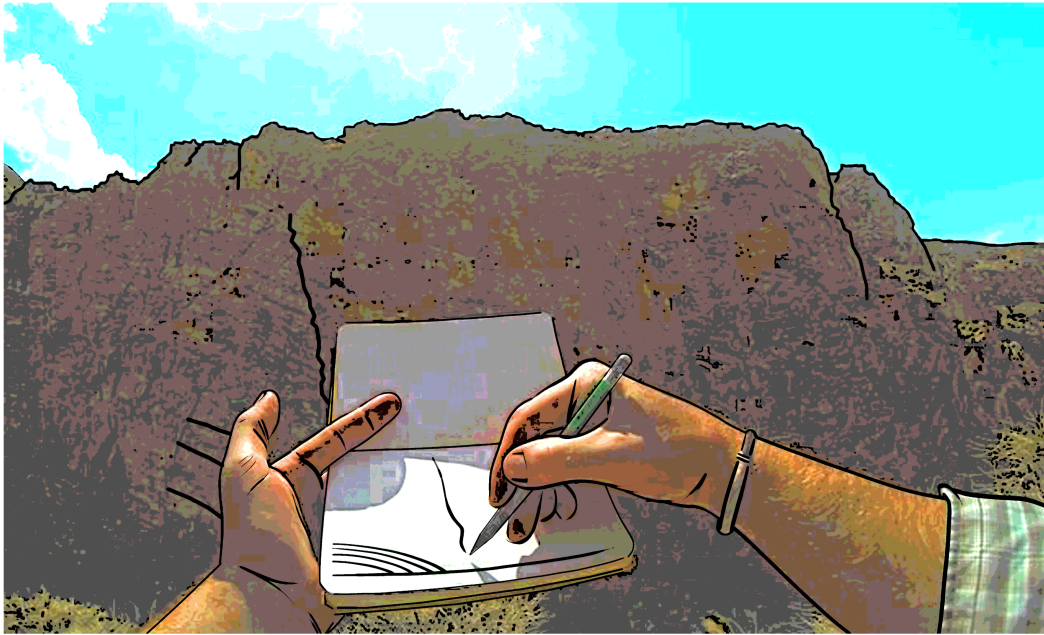


Figure 2.1: Jack's line-drawing of folds and fault devil's gate in California. The road-cut in the background is approximately 40-50 meters away from participants.⁴

On the day of recording, a group of geologists and computer scientists travelled to a location near Death Valley, California, where on the side of the road sits a large road-cut exposing layers of sedimentary rock that has been folded and faulted by tectonic activity. The purpose of this day's visit was to provide the computer scientists the opportunity to observe how geologists used line-drawings in analyzing geological phenomena: Line-drawings are used in field geology 1) to locate and outline relevant features in the rock, 2) determine their relationships, and 2) to deduce a geological sequence. This is not simple in practice, however, as the stratigraphy can be quite overwhelming in its complexity, and, moreover, obscured by weathering or human activity. Accordingly, linework is often selective and analytically-

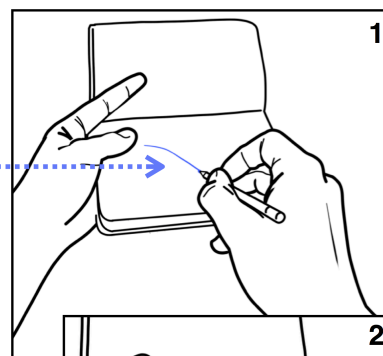
⁴ Video was captured via a wearable camera attached to the geologist's chest.

driven, rather than illustrative or representational in its development.⁵

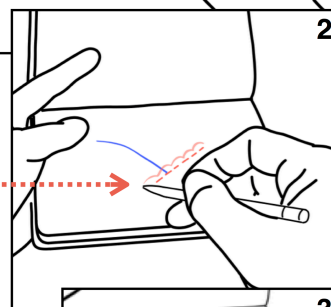
Linework accomplishes diagrammatic reasoning by exploiting two types of signs: icons and diagrams. An icon "...exhibits its object through a similarity or analogy" (Enfield, 2003, p. 10), while the diagram, though also iconic, exhibits its object(s) via an **assembly** of icons that depict the internal structure of complex objects, phenomena, and/or processes. These are typically highly selective and abstracted of the objects and the values they depict for the referent(s) (e.g., compare a two-dimensional subway map versus its actual three-dimensional route). They depict phenomena in a "visual skeleton form" wherein "the relations of parts are perspicuously exhibited" (NEM2:345) so as to make them visually accessible and actionable to the participants. When used in analyzing naturally occurring, heterogenous phenomena, as is the case below, we can see that these structures are not 'self-evident' prior to the linework, but rather emerge from its continual application. This is observable in Excerpt 1a below where Jack explains, via the lines, what he sees.

⁵ By "linework" I mean to refer to the accumulative, analytical work that is accomplished via the line-drawing. This is also distinguished from "lines," which more or less refers to the individual lines that the geologist draws.

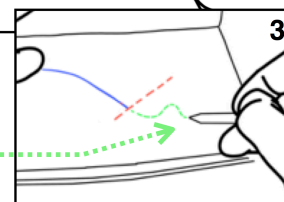
01 Jack: so I see something kind of coming down,
02 like (0.8) **this** ●



03 Jack: and over here?
04 **maybe** there's a fault here,



05 Jack: coming down,
06 and (h-) then there's **that hiccup** ●



Excerpt 1a: Jack's line drawing—taken from video recorded on a wearable camera attached to the participant's chest

Jack begins by drawing three lines in quick succession, while verbally glossing their referents. The lines depict some rough approximation of the shapes and positions of their referents vis-a-vis one another, which can later be used to locate them and make inferences regarding their causal relation. The glosses, however, aside from describing the 2nd line as "maybe...a fault," neither label the features as folds, faults, etc. Moreover, outside of their ordering and "and" prefacing (Heritage & Sorjonen, 1994; Nevile, 2006), Jack does not attempt to label their relationships to one another. Instead, he formulates the lines in a circumlocutionary manner, with evidentials ("So I see..."), deictics ("like this," "over here," etc.) as well as figurative language (i.e., "there's that hiccup"). In this respect, Jack's deictics and pointing gestures function as "Peircean indices picking out their referents by virtue of a shared spatio-temporal proximity" (Haviland, 2000, p. 21), and thus depend on his

interlocutor's mutual access not only to the "...diagram and the referential value of each of its nodes..." (Enfield, 2005, p. 60), but the very features in the rock-face that the diagram 'points' toward.⁶ While in the excerpt above Jack formulates the lines largely in indexical terms, as we will see below, he does so for the purpose of working towards describing these referents as categorical, geological objects. At this point in the analysis, however, the lines and accompanying talk capture little more than the place and appearance of their referents and their relation to one another in the rock-face.

The categorical nature of the referents begin to emerge as Jack's analysis evolves through the linework. After the excerpt above and just prior to the excerpt below, Jack displays difficulty in continuing the linework and stalls several times on identifying the depicted features. After some silence, he explains: "What I can't tell is::: if there's much offset."⁷ After a brief pause, he moves one to two meters to his left, takes off his sunglasses, and then states his recognizing a 'clear' offset in the rock-face, and immediately erases the dotted line replacing it with a thicker solid line along with notational arrows marking the direction of the fault.

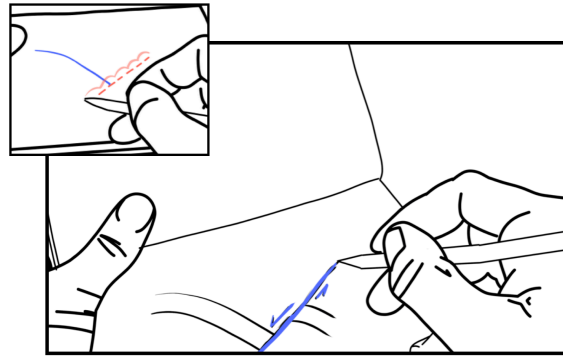
⁶ Assuring mutual access is not always an easy feat, however: while the rock-face is visible to both interactants, its distance from their position makes it difficult for either participant to locate the position of the rock-face that the other participant was describing.

⁷ A fault is defined as a break in a large body of rock marked by the displacement of the rock material on either side of the break (Merriam-Webster's Dictionary, n.d.) "Offset" is the observable distance of that displacement. As such, a fault is defined by the presence of displacement. Without it, the break cannot be called a fault.

01 Jack: what I can't tell
02 is:: if there's much offset

03 Jack: I didn't see this
04 °until I took off my sunglasses°
05 so this is kinda cool

06 (1.8)



07 Jack: yeah, yeah,
08 so it's clearly offset

Excerpt 1b: modifying linework in light of new understanding of the strata

We see a descriptive, evidential, and epistemic shift in Jack's analysis, accomplished through the linework. In depicting ostensible objects in the lines that are not yet described categorically or even committed to ontologically, that is, necessarily "there" as they appear, Jack operates on the lines for their transitional or provisional relation to their physical referents allowing him readily accessible and mutable objects on which he can coordinate his attention and allows for their continual reinterpretation and transformation through the analysis. Jack operates on the lines as placeholders for whatever his most recent interpretation of the referents are--even if that is only their shape and placement. The status of the line, whether it be an icon, index, convention, or proposition changes throughout its use. The line provides an interim form, where he can register bare percepts, suspicions, or claims regarding geological phenomena and then use those as points of comparison testing their "fit" with their corresponding structures as well subsequently structuring where and what to look for next in the rock. In addition to the lines' documentary function then, they also assist Jack

in organizing how he goes about scrutinizing the rock.

An obvious way in which Jack operates on the lines is by actively altering or editing them. Peirce emphasizes that any analysis into a given set of relations and their internal logic requires not only an "...observation of [given set of] relationships", but also an "active experimentation" on those, quite specifically so that their transformation might inform the analysis. (Peirce, 1971, p. 393). Manipulability thus plays an integral role in the use of diagrams as interpretive tools: In operating on the diagram as a set of dynamic and interdependently connected parts, and manipulating those parts, practitioners can observe how changes to parts of the diagram effect changes elsewhere in the diagram. The diagram in turn can be used to quickly develop, implement, and test multiple hypotheses about complex phenomena (Tylén, et al., 2015, p. 274). As seen above with Jack, these manipulations are possible even if the phenomena are not yet entirely understood, and indeed provide one means for his understanding to evolve through the linework. Alterations to the lines thus should not be treated as incidental to their use--that is, they are more than just the byproduct of some perceptual or manual error. Rather, each line acts rather as a proposition about the exact aspect of the world they depict--even if only appearance. Their placement provides for the further noticings of how they either resemble or differ from referents, how they are positioned, or what else in the landscape they make relevant. When Jack looks back to the rock, he is routinely assessing whether a line is adequate enough in its depiction, and then either let it remain, alter it, or erase it altogether. Any of these possibilities nevertheless inform his depiction and understanding of its referent(s) in the rock. Put otherwise, the 'mistakes' that we see Jack 'fix' constitute a necessary feature of the line-drawing as an analytical and diagrammatic tool.

Jack shows himself to already be quite aware of the diagram's manipulability: When he is asked by his co-participant what the different drawn lines signify, Jack does not immediately provide a response (that is, stating what the different lines signify); instead, he narrates what he is trying to accomplish with his first lines.

"Just for the moment I'm trying to put something here, so I can continue to modify it, and not get stuck--like what do I draw first? Or what's you know the most important thing? And so usually, how I get over that is just try to start making lines."

In 'just making lines,' Jack provides himself an initial "draft" of the object(s) of study, a draft that he can then edit and incrementally and progressively revise, until arriving on those lines that for him constitute the "most important thing(s)" in the diagram. His journey through multiple, iterative revisions of the diagram progresses through multiplicity of meanings, from the iconic and indexical to the propositional and categorical; this progression is made possible through the provisionality, indeterminacy, or liminality that Jack applies with each iteration of the diagram, and this provisionality in turn provides Jack the ability to operate on the visually-available structures of the referent(s) independently of his current understanding of either their classification or cause or consequence vis-a-vis other structures, thus allowing for their understanding to emerge as a procedural consequence of his analysis.

This practice operates as a type of what Goodwin (2013; 2017) describes as co-operative action: Whether adding to, changing, or revising the lines, we see each outcome co-operate on the structure (and resources) provided in the linework as an active substrate. The outcome of this action in turn constitutes the point of departure for subsequent actions (Goodwin, 2013, p. 17). Each phase then provides an evolving set of "resources for reuse, decomposition, and transformation" for building subsequent action, contribution, or analysis in the activity (Goodwin, 2013, p. 8). These actions are constructed across multiple materials

and modalities and in effect function diagrammatically because its activity is "...squarely situated between canonical practices, drawing, writing, and social interaction" (Streeck & Kallmeyer, 2001, p. 468). They include not only the talk, gesture, and other movements that occupy Jack's analysis, but the lines and the fieldbook as well--as "semiotically charged objects" (ibid). As will be argued below with gestures, the lines function provide what Streeck and Kallmeyer (2001) describe as "...an 'interface' for the interaction: a material structure with its own affordances and constraints (two-dimensional lay-out, conventions of writing, etc.) recruited as a field within which intermediate interaction results can be given external and enduring expression" (p. 472). The assembly of these resources and "accumulative mutability" provides a 'co-operative transformation zone' (Goodwin, 2011, p. 89), through which Jack can generate understandings of the geological structures. As Jack repeatedly shifts between the lines, to their referents, and back again to the lines, each shift mutually informs both his understanding of the prior and interpretation of the subsequent.

The co-operative action observed in the linework functions recursively--where many current and next actions (within the sketch) are occupied with changing, adding to, or erasing what are ostensibly the product of prior actions (i.e., the previously drawn lines). Each shift from scrutiny of the rock, or of prior linework, to re-looking or revising the linework represents a return to the line-drawing as a substrate undergoing continual emendation.⁸ To draw on an analogy from conversation analysis, the linework evolves less like an extended story comprised of multiple turn-constructive units, rather than it does a single turn-at-talk that is subsequently repaired and/or incrementally extended through repeated reformulation. Each alteration of the linework represents the continual remediation of something cognitively

⁸ Emendation (n) "The act of altering for the better." My purpose in using this word here is to explicitly underscore that Jack's modifications are performed specifically for the purpose of "...correcting what [he takes] to be erroneous or faulty..." in his earlier lines.

co-present, but not yet sufficiently perceived, articulated, or understood.

Jack's understanding and the diagram co-evolve through the accumulation of incremental changes. Indeed, the lines provide a means for tracking this evolution: Each line once drawn or changed remains for its subsequent re-use without having to be continuously reproduced, and each next line or change is interpreted specifically in relation its prior. The value provided by the lines in holding referents steady, however, is accomplished through its diagrammatic as opposed to illustrative use. The iconic relation between the diagram and its referent(s) is skeletal: the number of parts is minimal; each part is, moreover, summative of the feature(s) it depicts. The two bent lines on either side of the dotted line in Jack's line-drawing (i.e., the eventual folds on each side of the fault) are sufficient for the relative number of and difference in undepicted layers.

The linework functions diagrammatically because in each line and intersection the practitioner sees not only a referential value but a relational value as well: The bent lines in Jack's line-drawing, for instance, are treated as folds because sedimentary layers are known to fold as opposed to faults. Faults on the other hand are known to cut across rock, breaking apart structures, such as stratigraphy, in the rock. The lines and corresponding intersections are operated via a given set of relations and the underlying logic of those relations and their respective properties (Enfield, 2005, p. 60). While these emerge to the analyst in an ad-hoc manner, these properties can be seen as providing interpretive frames for the practitioner: For instance, in placing his suspected fault after the first bent line (Figure 2, A to B), Jack (re)specifies the first line into being 'meaningfully discontinued' as opposed to being abandoned at random. And although we do not see its realization until later, his third line, the "hiccup" after his dotted line emerges later specifically as the offset continuation of his first

lines on the other side of the fault (Figure 2, C to D). In the order of observable events, we can see that the discontinuation of the initial line and high provisionality ascribed to the hiccup occasions the search for and subsequent discovery of their being offset thus confirming the discovery of the fault. This does not mean that they "cause" it in a mechanistic manner, but rather that they anticipate potential outcomes and frame what the practitioner does next, what phenomena will be relevant, and where. We can see a more mechanistic relation between the discovery of the fault and how that results in the cascade of transformations in the diagram: It precedes Jack altering his second line (the suspected fault) into a unequivocally clear fault with notational arrows showing its direction of movement, and this in turn provides an account for why Jack should have noted a discontinuity in either his initial line. Accordingly, he alters both so as to make that offset more regular in appearance. Through each iteration, we see each of these objects emerge as categorical types through time, and from this, the larger semiotic complex that encompasses the various components of the diagram becomes structurally more complex and differentiated while becoming more stable and mutually-available for later co-operations.

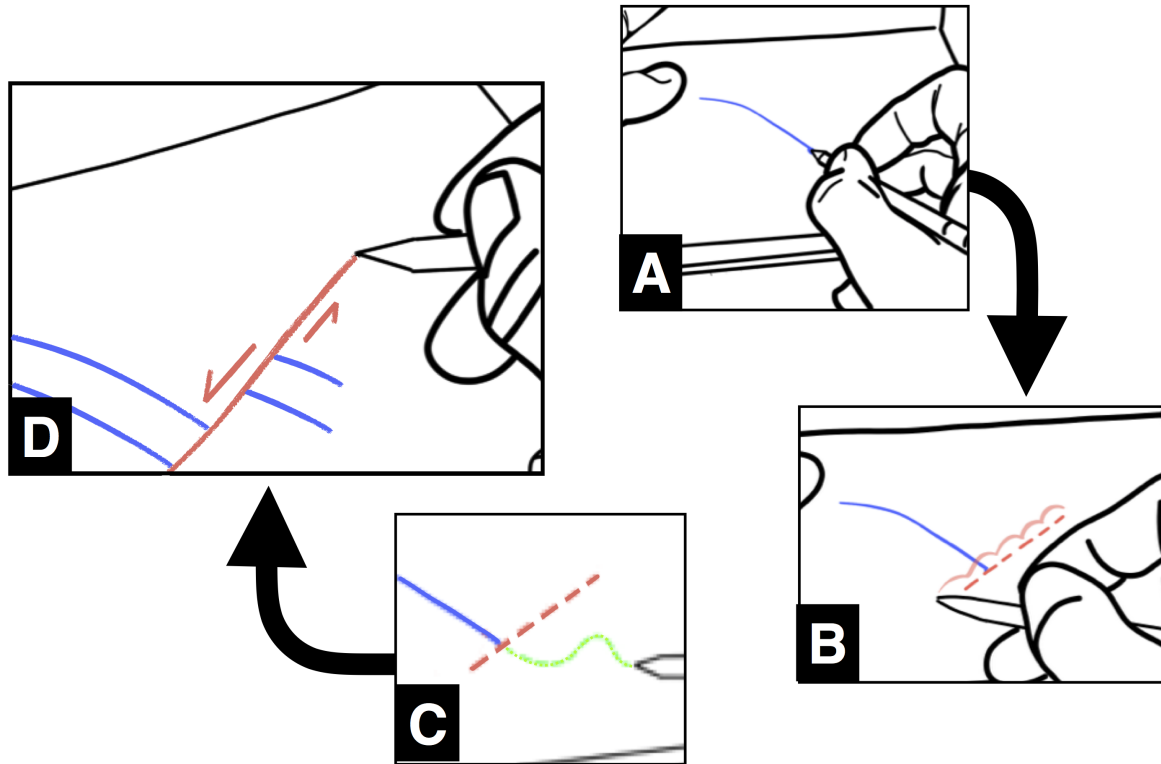


Figure 2.2: Occasioned discovery of the fault via linework

In the analysis above, I have examined diagrammatic reasoning as it is used in stratigraphic drawings in geological fieldwork with a focus on the practitioner's use of the lines specifically for their manipulability and ability to depict provisional referents undergoing analysis. This discussion provides an useful point of comparison for understanding how diagrammatic reasoning is manifested via gesture and how it manifests differently as a result. As will become apparent in the analysis, while many aspects of the gestural diagrams are analogous to their graphic depiction, we will see deviations between the two, due in part to the different limitations and affordances inherent in each medium.

Data & Methods

This corpus consists of four video-documented, multi-day, ethnographic visits to field-based projects with geologists. These were conducted either by Charles Goodwin or myself

separately or together and took place between 2011 and 2015. The locations for these projects included Yellowstone National Park, Madison River Valley, Montana, and two visits to Owens Valley, California. The study participants ranged from late- to early-career geologists, graduate students, advanced undergraduate researchers, and students in an undergraduate geology capstone field-course. In the projects in the Owens Valley, California, in addition to the geologists, the participants also included computer and information scientists as part of a multi-disciplinary collaboration to develop hardware, software solutions and large-scale database architectures to create, upload, and make available digital data for the field-based geosciences.. After the data were collected and brought back from the field, the videos were transcribed and analyzed using conversation analysis (Sacks, Schegloff, & Jefferson, 1974) with a particular focus on participants use of embodied action and gesture (Goodwin, 2000; 2010; Mondada, 2013).

Diagrammatic Gesture

Gestural diagrams have been described most extensively in Nick Enfield's research on the gestures Lao speakers use in depicting kinship trees and the elaborate fish-traps they use (2003; 2004; 2005). The gestures "...represent information analogically, iconically, and indexically" (Enfield, 2004, p. 58), and appear as "...complex visual illustrations" (Enfield, 2005, p. 51). They, moreover, function as "composite" or "hybrid" actions (Enfield, 2009; Streeck & Kallmeyer, 2001, Goodwin, 2000), and distribute their meaning(s) across different modalities (i.e., gesture, speech, gaze, material artifacts, etc.), across multiple speakers' bodies, and tend to depict "...complex physical artifacts, where speaker[s] need to refer to multiple features of a three-dimensional object (Enfield, 2004, p. 60). The excerpt below provides an example of participants collaboratively constructing a complex, multi-part

diagram via gesture. More importantly though, this gestural diagram is also revealed to function diagrammatically and provide participants with a visually-mediated, multi-part model that they use not only in collaboratively reconstructing a geological sequence, but in isolating specific components of that sequence and analyzing their "fit" with the corresponding features in the co-present landscape. Accordingly, rather than being analyzed in a holistic fashion, the diagram is constructed componentially and is increasingly oriented to for its depiction of the terrain in terms of its geometries and topologies. When diagrammatic reasoning is attempted via gesture, co-participants use the gestural diagram much as Jack does his graphic diagram: as a working hypothesis for geological structures in the co-present landscape, and in doing so, operate on the gestural components of the diagram for their transitional, provisional, and mutable functions.

In the excerpt below, I analyze a geology instructor and three senior students using a gestural diagram for reconstructing transformations in the terrain in which they are currently standing. I analyze the use of the diagram according to the features previously described in Enfield: a) their combinatoric properties and segmental construction, b) their extended duration, and c) their overall "temporal persistence and structural integrity" (Enfield, 2003 p. 59). I will also analyze these features for how they facilitate diagrammatic reasoning in the Peircean sense. Here, the participants are reconstructing the evolution of ravine. The ravine is shaped by the interaction between the river that runs down its length and a seismic fault cutting across the river. There is evidence of numerous seismic events--the last occurring in 1959--but because the river shifts with each event, it partially destroys evidence of prior events. This data comes from the "Geo-morphology" module of an undergraduate geology capstone field course. The students were expected to 1) survey an area, 2) identify and

measure various landforms (river-terraces, fault-scarps, and flood plains, etc.) created by seismic (faulting) and/or geomorphological processes (erosion, deposition, etc.), and 3) propose the order of events rocks that created the current landscape. At this point in their project, the students have already surveyed the area, identified the relevant landforms, and measured their profiles. As we join the action, the group is reviewing the geological sequence they have so far reconstructed.

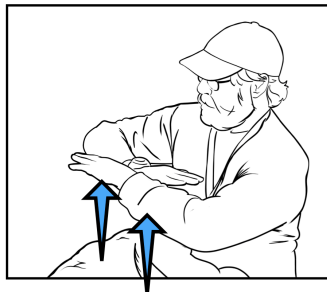


08 Dave: so:: y'go^tta surfa:ce

09 (.6)

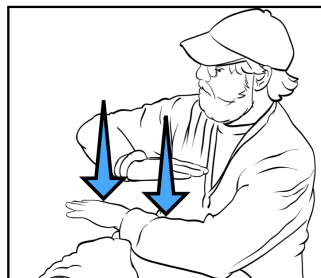
10 Shelby: go^tta surfa:ce

11 Dave: [n'^it's faulted.



12 Jacob: [n'^it's fault[ed-[f'ltd

13 Shelby: [it [faulted,



Excerpt 2a: The instructor gesturally reconstructing past seismic events

Dave begins the reconstruction in Excerpt 2a, line 8 with "so you gotta surface", while presenting his right arm as the horizontal, nominal surface. Haviland (1993; 2000) describes a similar gestural practice in storytelling, where the teller would gesturally "baptize" narrative spaces in the story and assign them with associated points in the participants' local space.

Interactants would continue referring "back" to that space later in the discourse, even after intervening signs (1993, p. 18). Moreover, the nominal space created via Dave's arm is itself mutable, and can be altered, left unaltered, or extended with additional gestural components. Subsequent transformations in the shape or position of Dave's arm, however, are transferred onto the surface in the narrative space (i.e., the geological terrain and its order in the sequence)--the initial label "surface" is thus partitioned through transformations in the gestural diagram: We see the original surface "faulted" through lines 11 through 13 resulting in a "lower" and "upper" faulted surface. All of this complexity emerges in the diagram without it being explicitly labeled'.

The meanings that Dave applies to the gestural surface also organize how and which subsequent motor movements contribute to the unfolding narrative: As he lifts his left arm to the same height as his right before dropping it over his and others' turns-at-talk in lines 11-13, he does so with that surface acting as the initial, original surface provided in the narrative. While Dave lifting his left arm is instrumental in getting it into place as part of the contiguous "surface" he begins with, it is the moment when he subsequently drops his left arm that provides the meaningfully next event in the geological sequence. Dave's recipients interpret these movements similarly and anticipate the next event in the reconstructed sequence: Both Jacob (who is standing to the left off-screen) and Shelly chorally reproduce Dave's utterance in line 11 in their own talk in lines 12 and 13.

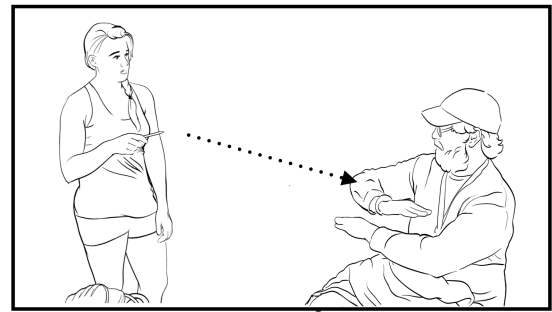
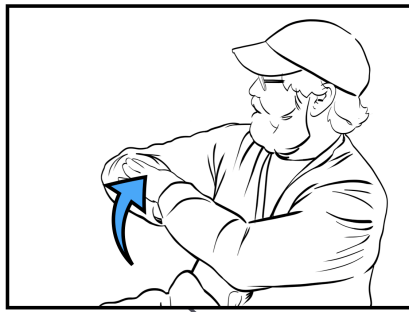
After reaching his faulted configuration in Excerpt 2a, line 11, Dave continues to hold the gesture into the subsequent talk (only breaking it momentarily in 2b below). In doing so, Dave provides the gesture with an interactional durability, and thus available for him and his co-participants. In expanding the diagram from one arm to both, he segments the depicted

terrain across different nodes or surfaces of the diagram as articulated in the initial gesture space and its (re)configuration. Dave's trek through the faulting progresses in an incremental or segmental fashion, where gesturers build multi-part diagrams, such that each next gestural part is physically built from or with spatial reference to a previously provided gestural part. Enfield (2004) describes a similar segmental construction in his gestural diagrams, where different hands and arms (or other bodily surfaces) are organized in a passive-dominant relationship, where "... one hand is passive (i.e., is held still) while the other hand articulates some representational gesture" (Enfield, 2004, p. 59). This is how Dave depicts the faulting in 2a: His initial arm (the initial surface in line 8) is held still as he lifts the next arm into position (line 11). In these gestural diagrams, however, the gesturer reconstitutes the original gestural space for his initial surface from one provided for entirely within one arm to one provided for by both arms. This not only allows his depicting the subsequent faulting, it does so while preserving the historical relation between the now-two depicted surfaces. This reconfiguration also depends on the complementary preservation of the original surface in his right arm.

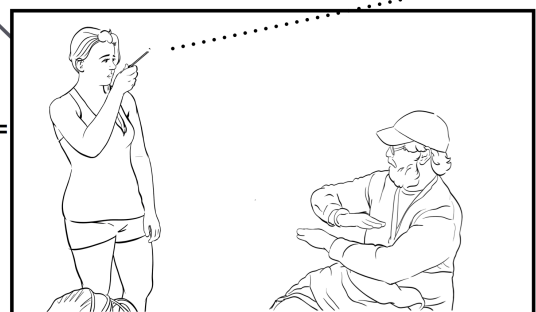
Because the gestural diagram models transformations in the ravine's terrain, it acts as a proxy for both the co-present landscape as well as the reconstructed sequence. As such, a component of the diagram can be oriented to for either its depiction of different terrain in the ravine or for its relation to its prior and subsequent iterations of the diagram. The semiotic complex engendered in the diagram thus expands beyond its internal structure (as a set of descriptors, e.g., the surface, the fault, the upper-and lower-most fault scarp, the river, the river-terrace, etc.) to encompass the both the visible, co-present landscape as it currently exists. We will see Dave and Shelly in Excerpt 2b shift between these different frames of

reference for locating a surface in the diagram and the terrain.

In lines 23 and 25, both Dave's question ("Where's this surface now?") and Shelly's clarifying try, "the original?" are performed with points towards Dave's upper right arm (specifically its uppermost flat area). Shelly's response in line 27 is referenced with a point towards the upper terrace. He confirms her response with a nod in the same direction in line 31 (not shown). The participants shift from the gestural diagram to the co-present landscape and back again. This spatial relation, however, is interpolated with a temporal one: Both Dave's initial question and Shelly's eventual response (lines 23 and 27, respectively) are about locating where a referred-to surface is *now* in the landscape, as well as where it first appeared in the reconstructed sequence: Shelly's request for clarification shows the surface that Dave formulated is also the "original" surface that he first depicted in Excerpt 2a, line 8, "so you gotta surface." Prior and subsequent instances of the diagram are "calculably recoverable" (Haviland, 1993, p. 37) from the reconstructed sequence.



23 → ^wh- ^where's this surface now:.
 24 (1.)
 25 Shelby: <the [original? |
 26 Dave: [()
 27 (2.) |
 28 Dave: way ^up there.
 29 (1.6)
 30 Shelby: ((nod))
 31 Dave: ^old:est's on top.=
 32 =[(right)
 33 Shelby: =[yup



Excerpt 2b: exploiting the gestural diagram for its iconic and indexical properties

An recurrent feature in diagrammatic gesture is the gesture being "held steady" (as Dave does) in mid-air for extended durations (relatively speaking). In his description of gestural diagrams, especially in their segmental construction, Enfield notes these "gestural holds" (2004, p. 117), occur where a gesturer holds a gesture (often left over from the prior gestural configuration) in shape, position, and duration. Enfield suggests that holds, especially when constructed in this passive-dominant structure described above) allow gesturers and recipients to structurally link next utterances with prior ones, allowing participants to manually represent multiple concepts simultaneously while elaborating on meaningfully complex systems, structures, or processes. Structure depicted in the prior gesture can be carried forward to a next utterance/gesture while simultaneously being narratively backgrounded (Enfield, 2004, p. 117), allowing the gesturer to describe processes

requiring the coordination of multiple, interacting parts, as is the case in this reconstruction.

The instances in the geology data where participants hold a gestural configuration appear to be operated on differently from the gestures in Enfield's work (2003, 2004, 2005). Dave holds his gesture well past its accompanying talk. He continues to hold it even as he initiates a new sequence of talk in the reconstruction--we see this in his question in line 39, Excerpt 2c: "then what happened."

38 Shelby: so: [the:n there would've been li::ke,
39 Dave: [then what happened?



(.4)

41 Shelby: an in^cisio::n (in) the ri::ver
42 leaving [that original:: plain,=
43 Dave: [okay



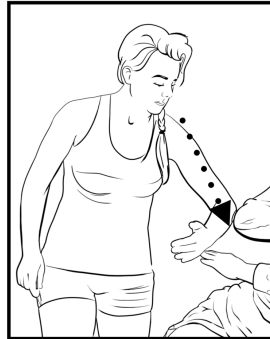
Excerpt 2c: student gesturally rendering river against instructor's gestured faulted surface

In holding the gestural diagram steady, Dave appears to do so in making it accessible for Shelly and the others in inquiring about the reconstructed sequence. In doing so, he also makes it accessible to others for building next actions, such as is the case in Shelly's contribution to the diagram in 2c. In line 38, as Shelly begins describing the next event ("So

then there would've been like..."), she stops mid-turn, moves towards Dave, leans in, and places her gesture directly over Dave's diagram, before continuing in line 41: "an incision in the river" She gestures directly across his upper right arm appropriately while making an incising or cutting motion against his gestured fault. She initiates this ahead of Dave's question in line 39, suggesting that she operates on the emerging organization provided in the gestural diagram. The placement of each the gestured incision and its subsequent floodplain (line 42) appear both closely coordinated with their placement vis-a-vis Dave's upper fault, making each internally consistent with others in the diagram and its larger semiotic complex.

As a diagrammatic practice, gestural holds appear to provide a physically and discursively manifested space for participants to provide structure for their analytical work, much as Jack's line drawing did. Here, the senior and novice geologists also use gestural holds (and by extension different components of the diagram) to find and probe structures in the co-present landscape. This appears accomplished in part by holding some diagrammatic structure to compare it with corresponding structure in the landscape, continually testing the "fit" of each with the other. The ability to compare structures is facilitated when different diagrammatic components can be decomposed and isolated from the larger diagram and juxtaposed against its corresponding structure in the landscape. This is readily possible with gestural diagrams, as can be seen in Excerpt 2d, lines 53 through 57.

44 Dave: >^now what< surface's: tha::t?
 45 (.4)
 46 Sheryl: which o:ne?
 47 (.)
 48 Sheryl: that one I just cut in,



49 yeah
 50 that- ::cou::ld:-
 51 Dave: just- you- you got three surfaces here
 52 so which one is that?

Excerpt 2d: Student re-formulating prior gesture for scrutinizing the current terrain.

Shelly's gesture in Excerpt 2d is similar in shape to her depicted river incision in Excerpt 2c, line 41. Here, it follows Dave asking her to locate the previously depicted surface: "now, what surface is that?" (line 51). She leans in again towards Dave's 'upper fault' re-gesturing her prior incision, while requesting clarification with "which one?" As she then adds a candidate ("the one I just cut in?"), she returns to her prior upright position and looks toward the raised terrain behind Dave--as she continues to hold the incision steady. In contrast to just gesturing the next component in the gestural model as in 2c, here, Shelly recycles the prior gesture in service of responding to Dave's question. While the gestures appear similar then, this sequence is actually closer in structure to that in Excerpt 2b--S1: Wh-question > S2: Request for Clarification > S1: Confirmation > S2: Response. Here, however, her gesture is re-purposed for probing the focal, co-present terrain with the end of finding its referent in the landscape. Rather than just operating on the diagram as a depiction of the terrain, she uses her gesture (and diagram by extension) as a perceptual tool for probing a given space--as it is

both depicted in the diagram and located in the co-present surround. The distinction becomes more apparent if we compare this gesture and its sequential context with those from Excerpts 2b and 2c.

Shelly's gestural hold in Excerpt 2d provides what Goodwin describes as an "architecture for perception" (2002)--a fabricated perceptual tool used by members in communities of practice for selecting and sorting what is otherwise continuous, undifferentiated stimuli into discrete, categorizable, publicly accessible and community-relevant structures. Shelly's gesture--recycled from the just prior sequence--is decomposed from the diagram and held 'mid-air' as Shelly scrutinizes the co-present referent in the landscape. The gesture in 2d differs from the gesture in 2c. Whereas in 2c the gesture is provided as a depiction of the next geological event in the sequence, the gesture in 2d is not only reproduced from the prior sequence, but now emerges as she searches the terrain seemingly seeking a potential response to Dave's question. As such it is designedly "in-progress", actively under consideration, and thus not yet actionable or acted upon as a completed action. It works to resolve a particular perceptual or representational problem rather than standing in for the product of that resolution. Her inquiry is further embodied in the way in which she composes and holds her gesture. Her gesture here is occupied primarily with refining the shape and orientation of the surface caused by the river-incision (rather than just depicting the incision). She repositions it back in the diagram in line 53 sans her previous cutting motion. When she extracts it from the diagram, she preserves the exact angle of the gestured surface vis-a-vis her body, maintaining the angle of her forearm and her upper-arm from her torso, as she looks up to the co-present river-terrace. What she displayedly attends to is the topology and relative positioning of the gesture that she then extracts from the larger gestural diagram and use that as a perceptual aid

in her examination.

All subsequent, non-initial gestural reconfigurations in Excerpt 2 are the outcome of manipulations on the prior gestural diagram. Manipulability--a core feature of diagrammatic reasoning--manifests differently depending on the mutability of the medium in which the diagram is constructed (e.g., in gesture vs. line-drawing). The line-drawing is less mutable than gesture (i.e., neither the paper nor inscribed line disappear after their invocation in the activity). Manipulability here appears then primarily in how lines are put down, continued, erased, redrawn, etc. that the practitioner performs on the diagram. These manipulations in the diagram are meaningful, however, because they operate on already-provided structures--the lines but also the paper--that are not being altered. Preservation is given in a graphic medium, as both the page and inscription are (semi)-permanent and thus provide a relatively stable substrate for subsequent work and require little to no further work from the participants in their maintenance. When then discussing how diagrams are manipulated through their use, we should also take into account how they are simultaneously preserved. This is of course more evident when discussing a more ephemeral medium like gesture.

The ability to passively maintain a diagram as a co-present object in the interaction (as is possible in line-drawings) largely disappears in gesture. Instead, co-participants actively hold the gestural diagrams (or their parts) as they are operated on in their collaborative work. We see Dave hold the gestural diagram in Excerpts 2a through 2d, making it accessible for his interlocutors to collaboratively add to or alter the diagram. We see Shelly hold a gestural component of the diagram in Excerpt 2d as a perceptual tool for locating or assessing its corresponding referent in the landscape. The tendency for participants to hold their gestures for extended durations appear throughout the diagrammatic gestures documented in this

study. They certainly may appear as Enfield describes in his gestural diagrams (2003; 2004; 2005)--Dave essentially constructs his gesture in 2a with one arm held statically so that he could depict the faulting with his other arm. The extended durations observed in the geology data go well beyond their articulation in the gesture or talk however. They extend beyond the single utterance and even persist through multiple sequences so long as they are useful to the participants for building subsequent actions and advancing their coordinated activity. Holding a gesture in this context constitutes more than just a constructional practice; rather it is sustained as a constitutive feature of the interactional space within which the practitioners are operating.

The gestural diagram observed in Excerpt 2 is diagrammatic in Enfield's sense: It is a complex, multi-part model constituted via gesture that is incrementally assembled (or segmented) along nodes that prescribe some structure, object, or other referential value (Enfield, 2005, p. 60); these are further interconnected by a given set of relations and their respective relational logic that binds the individual objects with their respective properties" (ibid). The assembly of the diagram is accomplished similarly to the passive-dominant constructions described by Enfield, where each gestural increment represents the outcome of a coordination between a passive component held steady against the dominant moving component, allowing the participants not only to depict phenomena with complex interacting parts but also to animate those as well as the participants do in the reconstructing the geological sequence.

The gestural diagram described above is also diagrammatic in the Peircean sense: Participants use it as a visually-mediated tool for revealing and investigating geological structures in the landscape. The gestures being routinely held in 'mid-air' for extended periods

appears to be designed for the purpose of making the diagram accessible to interlocutors as well as to the gesturer. The diagram is constructed as a co-present model in place of its referential structure(s) in the landscape with each component being constructed as a publicly accessible and actionable substrate for multiple participants to co-operatively use, re-use, and transform through re-use. To the degree that the gestures embody representations, the participants continually orient to these rather for their interrogative use. The participants above use the diagram first to ask "what happened next" in the reconstructed sequence. Shelly subsequently uses the diagram to probe the co-present landscape. These gestural diagrams are then not oriented to simply for what they depict but rather for what those depictions subsequently make possible. This is most clear in Excerpt 2d where we see the gesturer construct her gesture in order to extract one component from the diagram and use that as a perceptual tool for probing and analyzing geological structures in the co-present landscape.

The gesture in 2d (i.e., the depicted river terrace) works as a tool for solving a particular perceptual problem initiated in Dave's question. Accordingly, we see Shelly use it in formulating a response--much as she uses her point Excerpt 2b to clarify which surface is being asked for. Overall her gestures, whether a point or depiction, function as a means for probing the landscape locating a referent for subsequent (re)formulation. Her gesture in 2d differs in her using it as a perceptual tool, where Shelly essentially "looks through" her gesture in order to locate a matching surface in the terrain.

A similar use of gesture can be seen in Excerpt 3, except here the gesturer performs for his recipient to look through. This excerpt comes from the "structural mapping and metamorphic rock" module of an undergraduate geology capstone field course. The students

were expected to survey a large area, identify various metamorphic rocks, and plot the locations of geologic structures including contacts, faults, shear zones, folds, and other features on a topographic base map. In this excerpt, three geology students--Drake, Karl, and Kyle--are mapping metamorphic folds over a large geographical area, when they decide to sit at an exposed hinge line and record various measurements in their fieldbooks. Prior to the transcript, they are approached by their teaching assistant, Trevor. As we join the action, we see Drake reading the measurements for the hinge line to Trevor in lines 1-5, when Trevor challenges Drake's reported plunge with his pitched, elongated repeat of Drake's prior report:

"plunge of forty::ty:::?"

jc14-42_6-25_folds_B2_13-12-23a "plunge of forty"

01 Drake: so I had a plunge of fo:rty::,
 02 Drake: -two sixty six =
 03 Drake: =we took one with,
 04 (.8)
 05 Drake: °a brunton::=°
 06 Trevor: =plunge of for^ty::?
 07 (.2)
 08 two sixty si:x.
 09 Drake: f'r: the hi:nge: line?

10 (1.8)

11 Trevor: °oh yeah::°

12 (1.)



13 Kyle: >-Cuz I pu:t my pencil like this<=
 14 Kyle: =maybe i did it [wrong=
 15 Drake: [yeah maybe put (it)-
 16 Kyle: >>I put my pencil like this.
 17 (1.6)
 18 Trevor: yup.=no. (i')looks good.
 19 Kyle: okay.

Excerpt 3a: student gesturally rendering measured angle against a bedding layer in his recipients' line of sight

Drake's gesture in lines 10 and 11 is provided as a response to Trevor's challenge. Drake follows Trevor's challenge with his incremental "for the hinge line?" in line 9, clarifying the source of his measurement (while also effectively reasserting it). When no immediate uptake

appears, Drake, situated between Trevor and the hinge-line, turns toward the hinge-line, away from Trevor, while simultaneously lifting his left arm up and torquing the blade of his palm and lower-arm toward the hinge-line while emulating the curve in its fold. Finally, as he does so, he leans back, providing Trevor a better view of the bedding layers and gesture. Trevor subsequently accepts the measurement in his "oh yeah" in line 11.

Both Drake's gesture here and Shelly's gesture in Excerpt 2d are constructed via the lamination of their gestures over co-present structures in the landscape, specifically for one point of view. Whereas Shelly's gesture in Excerpt 2d, appears performed for her own use, Drake's gesture is rather laminated for his recipient, Trevor's, point of view. It differs from most gestures--rather than being produced within the gesturer's "gesture space"--the imaginary space in front of his body (McNeill, 1992), it is constructed within Trevor's point of view and its referent. This placement is sensible given the course of action it pursues: While Shelly's gesture is performed for the purpose of formulating a response to a prior question, Drake's gesture instead constitutes a reformulation of and evidence for his previously reported measurement--a measurement that was just challenged. In doing so, Drake transduces the rock-outcrop in his gesture into its focal features (i.e., its hinge-line, the angle of its plunge, 40°, etc) to make that accessible to Trevor.

Immediately following Drake and Trevor's exchange, Kyle also responds to Trevor's challenge. His response in 3b, lines 13-14, and 16, like Drake's before him, is provided via physical demonstration. Kyle's demonstration, however, is in how the plunge was measured: He turns toward the outcrop, and reclining onto his side reaches out inserting a pencil into a rock-crevice and states: "Cuz I pu:t my pencil like this. Maybe I did it wrong...I put my pencil like this." Trevor subsequently re-accepts and re-confirms in line 18, "yup=no.

(i')looks good."



13 Kyle: >-Cuz I pu:t my pencil like this<=
14 Kyle: =maybe i did it [wrong=
15 Drake: [yeah maybe put (it)-

16 Kyle: >>I put my pencil like this.

17 (1.6)
18 Trevor: yup.=no. (i')looks good.
19 Kyle: okay

Excerpt 3b: Kyle using pencil to demonstrate how measurement was taken

Although Drake and Kyle's depictions use different material resources, comparing the two provides insight into the mechanics of using and interpreting diagrammatic gestures. Both the gesture and pencil-insert are iconic: They resemble either the angle of the bedding layers at the hinge-line or depict how that angle was measured. Both work by composing an line from the bedding layers into three-dimensional space: the pencil-insert accomplishes this via a make-shift (and measurable) extension from the bedding layer, while the gesture accomplishes this by depicting the angle towards the bedding layer in his recipient's line of sight. Neither can the pencil-insert or the gesture, however, be said to depict 'forty degrees' without reference to the perceivable slope of the bedding layers projected into the euclidian space that the participants are operating within: The pencil-insert and gesture operate some aspect of the outcrop as a naturally structured mass a single and transduce that into imaginary geometric line into the co-participants' local space. That imaginary line is made amenable to

either being measured via the compass or assessed via Trevor's gaze as to whether or not it projects a 40° angle in euclidian space. Both the gesture and pencil-insert provide alternative means for depicting the relation between the gesture, pencil, and hinge-fold as primarily geometric in nature. Both the pencil-insert and gesture are means for making accessible a given structure in regards of its "set of relations and their internal logic," which requires not only an "...observation of relationships" but their active manipulation as well (Peirce, 1971, p. 173).

The depictions in Excerpts 3a and 3b provide further insight into the systematic layering of diagrammatic gestures with other inscriptive practices in scientific work. While each representation--the numerical measurement, inserted pencil, and gesture--are treated as signifying the bedding planes at the hinge-line, they do not entirely overlap in their respective significations. This is immediately suggested as much in Trevor's initial doubt and Drake and Kyle's responses to it. When the verbal/numerical description, "plunge of forty," is challenged by Trevor, Drake's gesture is provided as an intermediary form simultaneously providing an embodied demonstration of forty degrees while projecting that onto the bedding planes at the hinge-line. Conversely, Kyle's pencil-insert is provided as the intermediary form demonstrating how a "plunge of forty" was measured. Each intermediary is intrinsically tied to their co-present referent: Each depiction operates through its iconic relation to the referent; that iconicity, however, draws upon its co-presence with the referent; moreover, the gesture makes use of that co-present referent in selecting the recipient. As such, it continuously points toward it, effectively making the gesture indexical. In contrast then to their numerical measurement, their geographic coordinates, etc., the depictions cannot be meaningfully transported from their situated use. Once removed from the bedding plane, the architectures

projected by either collapses. This is more or less true for much of the linework and gestures analyzed elsewhere in the paper: The visual icons created through the diagrams provide architectures for perceiving and revealing structure, only through their continuous juxtaposition against co-present referents.}

Diagrammatic gestures simultaneously extract and project values from and onto their target structures. This not only makes assessable the particular structure being depicted, but in turn can also occasion participants' noticing of additional features in the rock. This can be seen in Excerpt 4. Here, two geologists, Ally and Steve, respond to Lu's initial question (lines 1-3) "how could these two (fillings) (1.) form this 'X' structure." In doing so they use both gesture and other resources in describing how two white lines in the rock under their feet (intrusions) can form an intersection in the rock.

01 Lu: how could these two (fillings)
 02 (1.)
 03 form this 'X' structure
 ...((omitted))

07 Ally: if this is the same one as this one
 08 Ally: you could almost put an interpretation of timing
 09 (.)

10 Steve: except [that- then [thi:s: guy hooks] off [that
 11 Ally: [o:n: [but im not sure:] [yeah
 12 Steve: like they were the [same
 16 Ally: [so:::
 19 =they almost seem like they're at the same time
 20 Lu: mh-mh-mh

...((omitted))

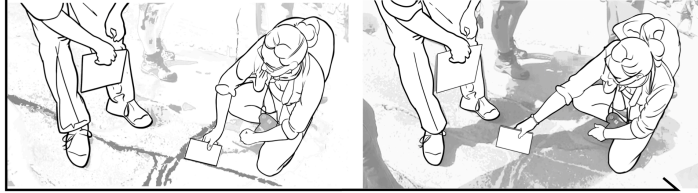
24 Steve: But it does it look like
 25 there was some left separation
 ...((omitted))



36 Steve: bcuz it's actually sitting- if it's sitting in like this

37 and over that way. [it might create [that separation
 38 Ally: yeah::: [cuz [based on this being

39 (1.8)



40 Ally: if that's all one plane,
 41 =°which°
 42 (6.2)
 43 Steve: it i:s dipping this way isn't it
 44 Steve: you can see down there
 45 (1.)
 46 Ally: yeah
 47 (.8)
 48 Ally: oh that's cool

Excerpt 4a: Steve and Ally using fieldbooks to depict planar angles for a co-present intrusion in the rock

In Excerpt 4a above, we can see that Steve and Ally's gestures share similarities in their composition, especially in their using their fieldbooks to project geometric planes. Their depictions differ though in how these planes operate on the co-present intrusion. In lines 36-37, while positing how a "separation" might have been created in an intersecting intrusion, Steve depicts a plane over the initial intrusion during his "if"-clause: "if that thing is actually sitting- if it's sitting in like this." He depicts the plane by holding his book directly over the intrusion while positioning its longest dimension to run parallel with the initial intrusion, while sloping it downwards towards Ally. Ally's subsequent gesture (lines 38 through 40) is constructed differently vis-a-vis the intrusion: She places the edge of her book directly against the intrusion while angling its slope upward toward herself away from Steve. She repositions it multiple times over the intrusion replicating the angle each time.

The participants' depictions are discrepant in both how they map onto the intrusion as well as what angles they depict: While Steve's depiction was placed "mid-air" above the intrusion with its angle being diagrammatically mapped onto the intrusion below, Ally's depicted angle in contrast is placed physically against the intrusion, diagrammatically extending its angle into three-dimensional space. The discrepancy in their depicted angles is

not trivial: Each presents mutually exclusive ways of depicting and conceptualizing the projected plane of the intrusion.

While neither participant explicitly recognizes the discrepancy (Ally's turn-at-talk "yeah, cuz based on that being..." is formatted as an agreement, for instance), the manner in which the participants follow this exchange demonstrates that each is actively orienting to the relation between the depictions as consequential even if not explicitly formulated in the talk

40 Ally: if that's all one plane,=which
42 (6.2)
43 Steve: it is dipping this way isn't it
44 Steve: you can see down there
45 (1.)
46 Ally: yeah
47 (.8)
48 Ally: oh that's cool



Excerpt 4b: Steve's point and revised depiction

Following this exchange, in the subsequent 6.2 second gap (line 42), after having lifted his gaze and scanned the surrounding matrix, Steve looks down the length of the initial intrusion, stands up and steps to the left of the intrusion and with a sweep of his, states: "It is dipping this way isn't it?" In formulating his discovery that the intrusion is indeed "dipping this way," he simultaneously acknowledges its assertion as being second to or derivative of some prior. This can be seen in the stress over the copula "is" and the tag-question, "isn't it?", marking the turn as reformulating a prior while limiting independence of its assertion. Altogether, it displays his action to be occupying a locally-subsequent and epistemically downgraded position vis-à-vis Ally. This is further suggested by the fact that Steve does not

pursue a response from Ally, nor does she seek to provide a response. Both participants treat the turn as reasserting something that was already given rather than stating something wholly new. Indeed, we only see a response from Ally after Steve points out where the angle of the intrusion is exposed in the rock in line 44.

Although Ally does not orient to the revised angle that Steve depicts in line 42, the fact that his gesture now aligns with the angle that Ally depicts, while simultaneously reformulating his talk as being a reassertion, shows his action co-operating on Ally's gesture as indeed having formulated the now-observable planar angle of the intrusion. We can see that, as no explicit statement was made regarding the angle of the intrusion outside of Ally's gesture, Steve's turn effectively agrees with Ally's gesture as a proposition.

Both of the participants' hybrid gestures perform diagrammatic depictions. Their use of their books makes them similar to both Drake's gesture from 3a and Kyle's pencil-insert from 3b. In placing her book directly against the visible line, Ally operates on the co-present intrusion to build her depicted angle. More importantly though, the angle that Ally projects is not actually visible at either of the segments where she positions her book. Rather, the angle that she projects is likely inferred from the visible area of the line approximately two meters in front of her (and out of Steve's view) where the intrusion is exposed. In depicting the same angle at the segment of line where she currently stands, she operates on the visible line as a single geological structure or as she states it in line 40: "all one plane."

In Excerpts 2, 3, and 4, we see both gestural and composite depictions used to decompose features from their surrounding rock or terrain and recompose into a local, publicly-available three-dimensional space, making them accessible, assessable, and measurable for both the gesturer and others. These diagrammatic practices appear performed solely for the purpose of

showing objects; rather, they are used to *seek* objects or for their better understanding. They provide a *perceptual architecture* that co-participants effectively look through allowing them to iteratively test the fit between the depictions and their co-present referent(s), in turn revealing temporally, and indeed analytically-rich objects in the geologists' work.

Participants actively incorporate disparate objects and materials (e.g., sketches, the fieldbook, the pencil, etc.) alongside gesture into the diagram, producing a mosaic of these different resources. The evolving diagram in turn co-operates on these materials as prior structures, exploiting their use for specific features, particularly their geometries: A prior speaker's held arm is operated on as a 'surface,' a pencil--a 40° angle, and a book--the projected plane of an intrusion. The material components are not treated as distinct from their corporeal counterparts in the diagram; rather they appear to provide a solution to a problem that is common throughout the examples, namely, how to hold different states of the diagram steady, so they and their referents can be further scrutinized, assessed, and emended if necessary. As the diagramming continues, however, especially if it grows more and more structurally complex, different components of the structure are successively 'offloaded' onto a material artifact as an already-given, continually-available, co-present structure. These in turn provide resources that are alternatively durable and mutable for the co-participants' immediate use, re-use, and transformation.

The geometry that is progressively constructed in the diagram is also progressively transposed onto the co-present terrain. Repeatedly returning to the terrain as they construct the diagram, the participants' gestures continuously relate the diagrammatic planes and lines along their different axes in that physical space. They point to or extrapolate from their co-present features (as seen in Excerpts 3 and 4) or they attempt to reconstruct the features in a

gestural space along their projected coordinates (Excerpt 2 and 5 below). Additionally, this can be accomplished solely with what the gesturer does with he or she is holding in his or her hands. Alternatively, in Excerpts 2 and 5, this is accomplished in part by how the gesturers situate their bodies (and by extension the diagram) in in the co-present landscape: In the river-fault diagram, Dave orients his body and constructs the diagram so it and the terrain are positioned relative to one another; in Excerpt 5 below, the person who initiates the diagram, Kyle, also formulates the diagram along a north-south axis.

The physically instantiated part of the diagram provides an accessible, extempore resource for rapidly prototyping successive diagrams, scrutinizing their larger semiotic complex, their underlying assumptions, and their constitutive internal and external relations and logical properties. Its provision more fundamentally makes available a range of efficiency that outclasses even simple verbal description. This can be seen in Excerpt 5, where Kyle uses a folded leaf of paper as an impromptu model for the gigantic regional folds that underlie the terrain that he and his team-mates are currently mapping. While the paper-model is subsequently developed by Kyle through a series of assertions about the reference landscape, what he and his interlocutor, Drake, eventually act on are primarily the diagram and its visual or spatial relation to the landscape and features within it. Its being continually accessible and malleable allows both participants to come to a sufficiently shared understanding in ways that are arguably not accessible in the talk alone. The diagram in this example, like any of those from above, appears extempore and improvised entirely for its use there and then. While not as evanescent as a gesture, the leaf of paper, as its used, is not intended to be documented in any chain of inscriptions that the geologists may leave with, and has no lasting permanence beyond this occasioned use. In contrast to 'immutable mobiles'

then (Latour, 1987, p. 366), the diagrammatic device (including even the linework from Excerpt 1) is not used for its mobility, while it appears specifically useful for its mutability. Whatever durability is provided to the diagram unfolds entirely within the boundaries of this use.

Just prior to the transcript, Kyle approaches with the paper-model as Drake measures the bedding layers of a nearby rock outcrop. Kyle positions himself approximately 2 meters uphill from Drake while facing him (see image in Excerpt 3a). There, as he orients both his body and the paper-model in the appropriate direction, he begins describing the folded structure, first with regard to cardinal North: "okay::, (.) this is north." (lines 8 to 10)

jc14-42_6-25_folds_B2_13-12-23b - "Paper folds"

08 Kyle: okay::,
 09 (.)
 10 Kyle: this is north
 11 (.)
 12 Kyle: these guys are going like this
 13 I think it- (it's)
 14 recumbent kinda like that
 15 (.8)
 16 Kyle: the folds?
 17 (.8)
 18 Kyle: cause that one bulges out further
 19 (.6)
 20 Kyle: [but there might be a fold on this tip



Excerpt 5a: Kyle and Drake comparing paper-model with terrain

Kyle's talk, from lines 8 through 20, emerges as a series of formulations that alternate between labeling the diagram, its co-present landscape, effectively "iconically mapping" (Taub, 2001; Becvar, Hollan, & Hutchins, 2008, p. 122) points on the diagram onto its proposed corresponding features in the surrounding landscape. The coordination of these punctuated descriptions is interesting on its own: while what Kyle is doing appears to be

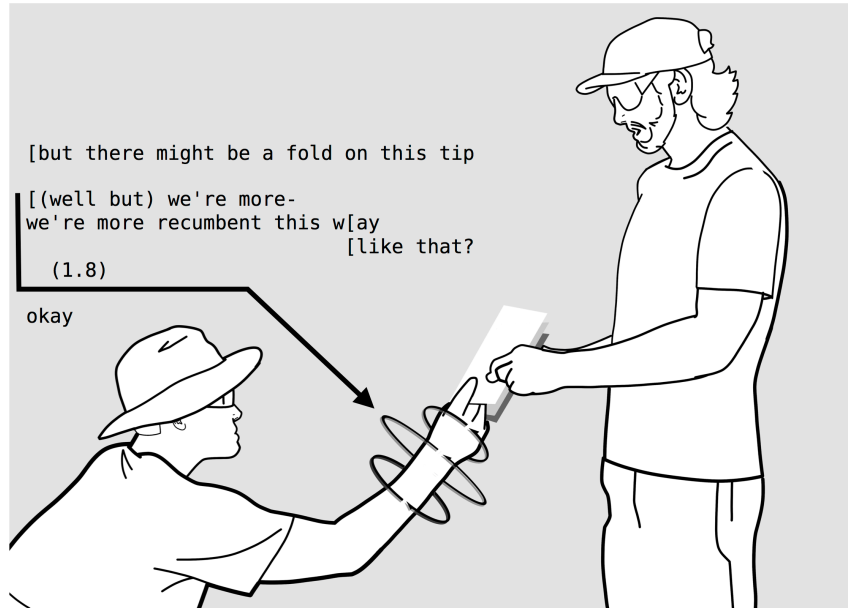
building a proposal, we do not actually see its final realization or know what action it might eventually be realized for, as that is undermined by Drake's subsequent corrections. It does appear to have a unified course of action, and, moreover, operates on having the floor for multiple turns-at-talk. Each turn-at-talk, though possibly prospective to more elaboration, is nonetheless observable for whatever diagrammatic presuppositions it has already displayed.

Both the diagram and formulations regarding it reveal the presuppositions and inferential practices that the co-participants hold and use in making inferences about the geological structure or its size, shape, position, or formation. In his description of storytelling among the Guugu Yimithirr, Haviland outlined what might be involved in following a story that operates in multiple interactional spaces:

"To follow the entire performance requires the interlocutor to superimpose a map of the local terrain on the narrated spot and then calibrate positions in the latter by recalculating positions in the former. In this spectacular feat of mental gymnastics, both location and direction are transposed...[and] the lamination of two different spaces, one local and one narrated...[are calibrated]" (Haviland, 2000, p. 42).

This 'feat of mental gymnastics' though elaborate and complex is nonetheless calculable along multiple axes, making presuppositions in the diagram (i.e., its relations and their logical properties (Enfield, 2005, p. 59-60) open to scrutiny and revision even if those are not articulated in the talk. An outcome of this opened scrutiny can be seen in Excerpt 5c below.

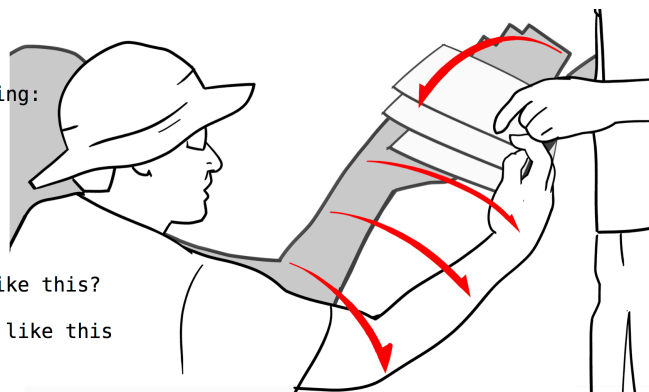
20 Kyle: [but there might be a fold on this tip
 21 --> Drake: [(well but) we're more-
 22 --> we're more recumbent this w[ay
 23 --> [like that?
 24 --> (1.8)
 25 Kyle: okay



Excerpt 5b: Drake manually altering the angle of recline of Kyle's model

As Kyle's continues with his description, we see in line 20 Drake reach up with his right hand to Kyle's model and manually alter its recline; he states concurrently: "(well but)...we're more recumbent this way" (lines 21-22). Just as Drake releases the model after his talk in line 22, he immediately reaches back up and alters it again in line 26. His alteration in line XX is more substantial; here, he pushes the bottom of the paper away to angle its top towards himself, stating in line 27: "and we're actually plunging this way" (Excerpt 5c).

25 Kyle: okay
 26 (.6)
 27 Drake: and [we're actually plunging:
 28 Kyle: [but I still-
 29 Drake: °is it- yeah::°
 30 well::::
 31 Kyle: it's back that way?
 32 it's- it's anticlinal.
 33 right?
 34 so it's coming-
 35 =[you think it's coming like this?
 36 Drake: =[well this-
 37 well that one up there is like this
 38 (4.)
 39 Kyle: yeah, you're right.



Excerpt 5c: Drake altering plunge of paper-model

Much like Ally's angled book in Excerpt 4, Drake's actions present a discrepant

understanding of the folds. His alterations, however, are produced as corrections. And whereas Ally's gestures depicted an alternative angle for the intrusion, Drake's corrections are not depictions in of themselves; rather each co-operates on Kyle's constructed diagram in the attempt to bring it into accordance with what Drake takes to be the 'actual' orientation and direction of the folds. Kyle's responses challenge the corrections: The first (lines 23 through 25) is brief ("like that?") but is quickly dropped with an "okay"; the second (lines 31 through 35), on the other hand, escalates over multiple interrogative TCUs, each either seeking confirmation of what Kyle or Drake proposes is the direction (and classification) of the plunge. His initial echo-question, "it's back that way" reformulates Drake's correction, while his subsequent tagged-question, "it's- it's anticlinal, right?" is produced while Kyle turns the model back to the direction he proposed, implying that he understands that direction--the one he had initially positioned the model--is "anticlinal."

The actions that participants deploy towards and from the model appear to operate on more than just its depicted components, but extend to the corresponding features in the landscape, and importantly do so along the properties of these interstitial relations. The participants further operate on premises that these components and relations are (or at least should be) consistent with one another. This presupposition is suggested in the sequence below in Excerpt 3e, beginning with lines 27, 29, and 30.

25 Kyle: okay
 26 (.6)
 27 Drake: and [we're actually plunging:
 28 Kyle: [but I still-
 29 --> Drake: °is it- yeah::°
 30 --> well:::
 31 Kyle: it's back that way?
 32 it's- it's anticlinal.
 33 right?
 34 so it's coming-
 35 =[you think it's coming like this?
 36 Drake: =[well this-
 37 well that one up there is like this
 38 (4.)
 39 Kyle: yeah, you're right.



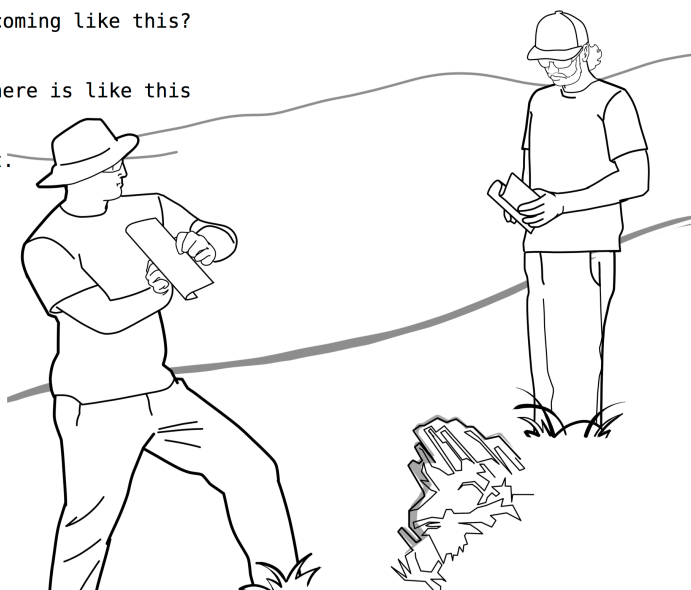
Excerpt 5d: Drake gesturing against exposed folds in his visual-axis.

Drake uses his gesture made with the blade of his hand, seemingly positioning it against the co-present bedding (similar to his gesture in Excerpt 3) to check the angle of his correction against the co-present bedding. This is suggested in his talk, where after his utterance in line 27 is abandoned, his next turn at talk is initiated with "°is it"--an interrogative hearably reassessing his prior correction. He then seemingly reconfirms it with "yeah," before hesitating again with his elongated "well" in line 30. In his embodied actions, we see Drake, as he stops mid-turn in line 27, release Kyle's paper model, stand up and turn to his right toward an exposed set of folds set in front of Drake, just behind and to Kyle's side. Coordinated with this movement, Drake extends his right arm towards the folds, gesturally depicting, what we assume to be the observable angle he can see in the fold's bedding layers.

31 Kyle: it's back that way?
 32 it's- it's anticlinal.
 33 right?
 34 so it's coming-
 35 =[you think it's coming like this?

36 --> Drake: =[well this-
 37 --> well that one up there is like this

38 (4.)
 39 Kyle: yeah, you're right.



Excerpt 5e: Drake using folded paper to demonstrate the plunge he currently sees in the bedding planes

Kyle and Drake's work culminates in the talk beginning with Drake's well-prefaced responses in Excerpt 3d, line 36-37 ("well, this- well, that one up there is like this") that marks its displacement in relation to Kyle's previous questioning. As he completes his utterance in line 37 with his comparative indexical "...like this," he demonstrates the plunge of the folds he was previously probing with his curved gesture in lines 29-35. His demonstration for Kyle here, is reformulated back into a material diagram Drake constructs out of his own folded piece-of-paper. Kyle eventually accepts this correction (abandoning his prior model) after a not-insignificant amount of time: approximately four seconds. Following the demonstration, Kyle looks from the model to the co-present outcrops, visually probes them and relents in line 39 with "yeah, you're right."

The switch to operating on the co-present landscape as opposed to the paper-model is illustrative of both 1) the affordances provided by the diagrams, their various components,

and their interrelatedness as well as 2) the limitations in the co-participants' ability to translate those into a euclidian description.

The outcrop that Drake and Kyle refer to in closing the inquiry is only explicitly formulated in lines 36-37. Nevertheless, the material diagram depicting the larger regional folding and the exposed folding are presupposed to be consistent with one another. The depicted components as well as their relational properties provide an analytical means for geologists to reconfigure and integrate additional, noticeable features of the landscape and alter the entirety of the diagram as a result. The diagram plays a productive role in the analysis and generates insights not provided in its earlier iterations. It does so because the participants continually operate on it for its being embedded in an object of study that ideally should constrain its form while simultaneously surpassing any iteration. Diagrammatic gesture are productive in co-participants' work because the diagrams constitute the physical manifestation of much larger domain of public reasoning in field geology. In assembling, segmenting, and joining components across participants' bodies, local and distal spaces, extempore materials, and/or graphical interfaces, the participants materialize this public reasoning in a local and intersubjectively shared space that is simultaneously physically- and thus perceptually-accessible. The amalgamation of these gestures, materials, and features in turn progresses toward an increasingly *durability* in the diagram--durability either in held gestural configurations, or where accessible, in the inclusion of material artefacts (e.g., via drawn-lines on a page, lines and angles projected by a pencil or fieldbook, or those constructed via a folded piece-of-paper). These gestural and/or material configurations are continuously co-operatively acted upon in various reconfigurations allowing participants to stabilize, extend, and reconfigure the diagrammatic relation(s) between the semi-fixed

diagram, its territorial surround, and the larger semiotic complex.

The diagram as a model of the folding exceeds its creators' ability in formulating its description even with geological terminology. From other moments in the data Kyle is revealed to be incorrect in his use of "anticlinal." Although, he is correct that the folds are indeed anticlinal (or more correctly anti-formal), what he depicts in the paper model is not anticlinal. Similarly, though Drake is correct in his correction, at other points in the data, it also becomes apparent that he is apprehensive about explicating the folding in euclidian terms. He does not explicitly alert Kyle that his model does not depict anticlinal. He does not even attempt to formulate the co-present hillside using geological terminology. Rather he transposes the exposed folds in the hillside using his own extempore paper-model and presents that as a response to Kyle. Nevertheless, it is the model with its its components and their spatio-visual relationship with the physical landscape that allows for the participants to propose, correct, and update propositions about geological structure prior to their acquisition of more formal descriptions.

Discussion

While the gestural described in this chapter, deployed in the practical work of field geology, are argued to constitute a novel use of gesture not previously described in gesture studies, they do nonetheless operate on features essential to gestures in general. In the discussion below I will connect this description of gesture with previous work, both in gesture studies as well as the use of gesture in scientific practice.

The analysis reveals diagrammatic gestures to routinely work in (de)composing physically, temporally, and conceptually complex phenomena. Both the gesturer and recipients continuously design and redesign their gestures according to their perception and understanding of geologic phenomena that are not only increasingly complex but often hidden under the earth or evidence ongoing geological processes. Accordingly, the interactants operate on their gestures and material depictions as components in a larger gestural and material complex (e.g., the faulted river gestures in Excerpt 2 and the folded paper in Excerpt 5) or as a transduction of some aspect of the co-present object (e.g., the 40 degree plunge in Excerpt 3 and the angle of intrusion in Excerpt 4). The affordances that provide for these uses in diagrammatic gesture can be observed in gesture other contexts.

For those gestures that depict multi-part, complex structures, interactants operate on the gestural/material depictions for how their topology approximates the topography of their referents. Although the diagrammatic gestures analyzed in this study appear as a form of professional practice, we can expect gestural diagrams wherever participants are describing multi-part, complex objects. The gestural diagrams described in Enfield (2003; 2004; 2005), for instance, are used by Lao speakers as they virtually map kinship relations or describe how their fish traps work. And though not described as such, Goodwin (2007) gives an example of

a speaker using a complex multi-part gestural depiction to show his audience how a blender he recently purchased was delivered with the glass carafe while missing both its lid and base. Similar to many of the excerpts analyzed in this chapter, the participants operate on multiple body parts incrementally in coordinating multiple gestural depictions as visually-available structures and then operate on those via their segmentation in subsequent depictions.

The use of gestures in depicting topographically-rich objects in scientific work has been described previously, most notably in Becvar et al.'s (2008) study on the gestures biophysicists use in modeling enzymes. Here, the authors find that while participants typically depict the enzyme with a single hand, the hand itself is configured to depict a topographically-complex surface: "[T]he gesture preserves not only the topology and shape between both the [enzyme's] loops and [the gesturer's] fingers, the active site and palm, but also the relative orientations of the loops and active site [on the enzyme]" (ibid, p. 128). The gesture gains currency as part of the lab's gestural repertoire appearing recurrently throughout the lab's discussions on the enzyme.

In the data in this chapter, we see similarly complex gestural/material depictions: In Excerpt 2, the faulted river terrain renders multiple surfaces, the fault scarp, the upper and lower fault, a river-incision, its resulting flood plain, and the river-terrace. Accordingly, the interactants can easily build actions from and toward the diagram. Similarly, in Excerpt 5, Kyle and Drake operate on the paper-model for the different significations that its topography exhibits while also operating on it for its cardinal coordinates in three-dimensional space. Similar to Becvar et al. (ibid), and importantly for this consideration of diagrammatic gesture, participants operate on the gestures not for their holistic appearance, but for their composition of segments and the relations that these exhibit.

A notable feature seen in diagrammatic gesture is the relatively long durations that interactants hold their gestures. This is not itself uncommon, though it has only been topicalized in Enfield's work on gestural diagrams (2003; 2004; 2005). The durations seen in the geology data are quite extensive. Enfield describes "gestural holds" (2004, p. 117) used by Lao fisherman as they describe how their fish-traps work. There, the gestures are held in shape and position for a given duration to depict the multiple, interacting parts (either the working parts of their traps or how they trap the fish). Enfield argues that the gestural holds emerge primarily from the segmental construction of the diagrams. Similar to the Lao speakers, we see the geologists holding gestures for the purpose on incrementally adding to the structure of the gestured diagram.

The gestural durations appears even more pervasive in the geology data than it does in Enfield's data, however. This might be explained by the relative difference in complexity between the different data: In Enfield's data, the segmental depth--the number of segments required to fully depict the referent(s)--appears limited to two to three segments. In comparison, in the geology data, the number of segments is much more extensive (in Excerpt 2 especially) necessitating interactants to coordinate more concurrent segments in the diagramming. This need is suggested as much in an early conversation that I had with David Mogk, the senior geologist seen in Excerpt 2, and collaborator on the research project. He remarked in only a slightly joking fashion that he often finds himself wishing, when describing geological structures to students, that he had eight arms to show all the interacting components he is trying to describe in the geology. Geologists likely hold gestures for extended periods simply because they require a greater number of concurrently rendered segments for depicting geological structures. This likely motivates the collaborative gesture

in Excerpt 2 as well as the use of more durable materials for diagramming, as seen in Excerpt 5. Each provides an extempore solution to the natural limitation humans have in gesturally depicting complex structures.

The number of parts depicted is by itself limited in accounting for the duration of the geologists' extended gestures. Enfield (2005), for instance, shows that even with fairly complex diagrams, participants do not need to continuously hold gestural segments. Because "...the spatial properties of [a] spontaneous representation directly preserve certain logical properties of the set of relationships being described" (ibid, p. 59), any gestural depiction, though transient and 'evanescent' on its own, can transfer its "signification...temporarily onto the chunk of space in which the gesture was performed" via metonymy (Enfield, 2003, p. 9). From these, interactants can scaffold subsequent gestures and operate on the meanings attributed within those spaces. These spaces are in turn reactivated throughout the diagramming, contributing to the overall "temporal persistence and structural cohesion of the diagram" (ibid, p. 26).⁹ This form of signification is evident even in the geology data, in the fault-river interaction in Excerpt 2 for example. There, Shelly does not continue depicting her river incision in order for its "surface" to then occupy that space. Dave's subsequent question, ">^now what< surface 's: tha::t?" is made sensible because it co-operates on that prior signification. Moreover, many of the gestural depictions observed here have relatively simple compositions: e.g., Drake and Ally's gestured angles in Excerpts 3 and 4, respectively. The observed tendencies we see for interactants to hold their gestures for extended or 'offload' parts of those diagrams to more permanent materials (e.g., field-books, the paper-model, etc.) appears situationally motivated by more than just the number of parts of the referent(s). I

⁹ This is almost certainly the case in Goodwin's (2007) analysis as well: though the speaker stops depicting the missing lid and base for the blender, they presumably do not disappear for the interactants.

will consider a number of these situated motives below.

In contrast to Enfield's data, the objects and spaces depicted in the geology are rarely static in space or meaning. This is best demonstrated in Excerpt 2 where Dave labels his right arm as "the surface" at the beginning of the sequence. When he depicts the faulting by lifting his left arm to his right and then dropping it, that is recognized as not only extending the surface depicted in his right arm, and thus faulting that into an upper and lower fault, it is recognized as transforming his right arm into both the "original" and "uppermost" surface." More importantly, participants operate on more than just the gestured segments, but do so with regard to the relations that inhabit the spaces in between. In Excerpt 2 this consists of the fault-line, but is also relevant to the gestured angles in Excerpts 3a and 4: the gesture is not self-contained; but is used for its geometric relation to a co-present fold or intrusion: the difference between forty versus thirty-five degrees is meaningful and possibly readily seen even in its gestural depiction. The interdependency between parts of the diagram and its referent(s) is, moreover, significant even when not explicitly oriented to in the gestural depiction: In Excerpt 2, the interactants operate on the diagram for its geometric relation to the larger semiotic complex, namely, the co-present terrain where it is situated. While physical proximity plays a constitutive role in diagrammatic gesture, it is rather in the particular relations that mediate that proximity.

The fact that interactants operate on particular relations between the diagrammatic gesture and its co-present referent(s) suggests that that a more basic motive for holding the gestures lies in their investigative and interactive use. In each of the excerpts, the gestures appear to be held for subsequent use and re-use, extending past their initial construction. Participants do this for both their own use, as in Excerpts 2 and 5 where Shelly and Drake use the gestures as

perceptual tools for visually scrutinizing their referents. Alternatively, participants hold gestures for an interlocutors' use, as in Excerpt 3 where Drake holds his angled gesture for Trevor, specifically placing the gesture outside of his own *gesture space* (McNeill, 1992) in Trevor's line of sight. This can be inferred in Excerpt 4 as well, where in using her book to examine the exposed intrusion, Ally's depicted angle nevertheless occasions Steve's subsequent discovery that her angle and not his own is in fact the correct angle of the intrusion. The extended durations that interactants hold their gestures appears as more a function of their investigative use and this in turn has interactive uses and implications given their collaborative work.

The gestures analyzed in this chapter are diagrammatic, not because they simply consist of diagrams in gestural form, but because they accomplish diagrammatic reasoning in the Peircian sense: the various manual depictions are used to locate features in the landscape and make those visually-accessible and re-present those via a "skeleton-like sketch of relations" (Tylén et al., 2015, p. 266) useful for revealing the relational properties of their referent(s)--specifically as (potential) geological objects. The abstract relations--e.g., the hidden structures, past geological processes, etc.--that are thought to govern the interaction between different features in the material surround emerge through time as geological objects do so through the diagram as an activity. The data shows this is accomplished in large part in the iterative use of the diagram, where in building a diagram (whether via sketched lines, gestures, or a folded piece of paper) that is first, liminal with respect to the referent and its categorical nature, and second, mutable or 'editable' (Enfield, 2003) in approximating lines, surfaces, and nodes of the suspected referent, practitioners are able to operate on the diagram and its parts as placeholders for co-present features, successively fitting those to the locations

and relations present in the rock, until the diagram and its parts emerge as propositions about the referent's geological ontology (e.g., as fold, fault, faulted river terrace, 40° angle, etc.).

The diagram, as medium and activity reveals objects in the co-present landscape only to the extent that it does so via the occasioned emergence of those in the practitioners' perception and understanding thereof. As seen recurrently in the data, when constructed by multiple participants, the diagrams provide for "... collective and temporally distributed forms of thinking" (Tylén et al., 2015, p. 266), modulating multiple participants perception of the relational properties, facilitating their collective understanding of the geological phenomena.

As the diagram evolves, successive reformulations in the diagram transform the interactants' overall understanding of the phenomena, even if those understandings were not present or anticipated in the initial gestures. In excerpt 1, Jack operates on the initial lines as provisional and incomplete--exploiting their indeterminacy for building his analysis of the stratigraphy. Likewise, in Excerpts 3 through 5, each interaction involves some formulated liminality that is subsequently revised through the diagramming: In Excerpt 3, Trevor challenges Drake's reported measurement prompting Drake to use his angled gesture to reveal the angle in the co-present bedding--in response, Trevor drops his challenge. In Excerpt 4, Steve revises his (mis)apprehension of the intrusion's angle upon having recognized the contradictory angle of Shelly's gesture. Lastly, in Excerpt 5, Drake corrects Kyle's paper-model with reference to the co-present folds he can see--similarly, Kyle accepts this correction based on his analysis of other exposed folds. Excerpt 5 is particularly informative in this regard, as it is later revealed that both Drake and Kyle are apprehensive about how to use "anti-clinal." The folded paper, in contrast, provides an immediately actionable object for confirming which plunge replicates the direction of the folds. Throughout the excerpts, we

see interactants operate to the structures even if they are uncertain of what the ultimately is depicted in the diagram.

The distinctions we draw between different categories of embodied action are always a product of the settings in which participants produce those. In mundane interaction, we may find it is useful (or at least not overly reductive) to say that the actor is either "describing," (i.e., using "...arbitrary symbols (e.g., words, phrases, nods, and thumbs-up) to denote things categorically"), "indicating," (i.e., pointing, indexing, or otherwise locating things in time and space), or enacting a scene for the purpose of representing another, that is, "depicting" (Clark, 2016). In the field geology, these distinctions become less useful for the analyst and seemingly non-existent for the participants: most gestural depictions operate on an indexical relation to points in the landscape, while most indexes in the gestural diagrams co-operate on the iconicity in depiction: when participants "depict" some structure, that is, show others what it looks or feels like, they simultaneously "indicate" it, locating it for others in the co-present landscape. Both are ostensibly performed for the purpose of describing it--that is, in order to "...tell others about its properties—to represent it categorically" (Clark, 2016, p. 342). Indeed, what the gestures signify evolves throughout their use: What is initially depicted tends to be vague, tenuous, and incomplete, noting only the lines, shapes, or relative locations of perceivable referents. Referents only emerge as definite, categorical, geologic objects through the diagramming. The liminality between something seeable and something knowable is understandable. In most instances, even those with more senior geologists, the participants are routinely operating at the furthest extent of their current understanding of the structures being investigated. Each revision in the diagram is situated between what is already known and what is already suspected. The objects, phenomena, or

concepts emerging through these diagrammatic practices are thus only marginally available for re-presentation. The tendency for participants to hold the gestural diagrams while actively scrutinizing them operates in large part on their active provisionality, skepticism, and uncertainty--these facets are not separate from the gesture but directly embodied in its production.

The diagrammatic gestures described here can be seen as form of representational practice, common in scientific practice. These "rendering practices," as Lynch (1985) describes them, provide one means whereby natural, in-situ phenomena is progressively transformed toward their final realization as classifications, measurements, images, etc. (Pickering, 1995, p. 102). In considering representational practices in science, previous work--as a counter to the naïve correspondence theory of representation--has tended to emphasize the rhetorical use of imagery: In rendering the material world into images, figures, diagrams, etc., practitioners are argued attend to the rhetorical and persuasive role imagery plays in engendering subsequent representations, whether that be in shaping subsequent observations (Lynch, 1985) or in persuading subsequent audiences as to the significance of cultivated materials (c.f. Garfinkel, Lynch, & Livingston, 1981). Accordingly, this position would contend that the diagrammatic practices described here should not be treated as *just* representations of an unmediated world, but rather, the products of the specific interactive spaces in which they are produced (Lynch, 1991, p. 74). Indeed this point is aptly demonstrated in Streeck & Kallmeyer's (2001) on hybrid inscriptional-gestural practices, where the authors argue that regardless of the "regulative rules" surrounding inscriptive practices, when "...used in social interaction, rule-systems give way to local considerations, yielding...local interpretations, rather than interpretations that could be 'deduced' from

context-free rules of the 'system'" (ibid, p. 465). We observe this in the data wherever the geologist the inscribed line or gesture for solely the shape it creates or line it projects in space. It is not used in its first use as an instance of any specific category; rather, recognizable, categorical objects in the landscape emerge as fully developed signs within the diagramming as a distinct activity. The diagrams, whether via line-drawings or gesture, are attended to for their reproducibility as specifically geological documents in a manner that is both "available and accountable" (Kitazawa, 1999, p. 298) to discourse in the geo-sciences as community of practice and body of knowledge.

While the rhetorical function of the diagram plays an integral role in their use, the geologists nevertheless operate on their diagrams for some tentative correspondence with referents in the co-present terrain. This correspondence is provisional in each iteration, however, and the diagram emerges in far more incremental manner than could be expected if we only considered how inscriptions emerged in "representational chains" (Lynch & Woolgar, 1990) or in "cascades" of material, statistical, and algorithmic transformations through which nature is rendered through different levels of abstraction (Pickering, 1995, p. 99; Fountain, 2008, p. 119). While through diagramming, practitioners may take "the visible form of 'endogenous' geometries" inherent to the natural object and adapt those to the "angular and dimensional properties of 'exogenous' graphic formats" (Lynch, 1985, p. 53) inherent in the diagram, never in the field geology, do we see practitioners treat these as "embodying the 'natural object'" (ibid, p. 37). In contrast, the analysis repeatedly shows that even in continuing to iteratively approximate the diagram towards its referents, the practitioners necessarily orient towards the provisional and tentative nature inherent in the diagram. Both novice and senior geologists routinely operate on uncertainty as integral

feature of their diagrams, treating uncertainty not just as a deficit of knowledge, but embodied in the diagram itself. As such, indeterminacy constitutes an analytical domain that is thoroughly investigated through the use of diagrammatic reasoning, which in turn is facilitated by the construction of action across different media which in turn is mutually elaborated on and transformed through the practitioners' iterative, dialectic, and dialogical engagement and investigation of their phenomenal world. Geologists' use of line-work and gestures as both visual mediums and methods provides a unique insight on a number of analytical issues: How action-formation is deployed and interpreted when thoroughly integrated with gestural, embodied, and/or graphic/textual resources. How can these formative processes inform our understanding of the ontology of different facets of both linguistic and non-linguistic meaning, including iconicity, reference, deixis, evidentiality, and epistemics as displayed in interaction. As will be argued in the analysis, the semiotic resourcefulness provided by either line-work or complex gestures in in situ geologic description is their diagrammability, that is, their utility in quickly rendering some geologic phenomena, but doing so in a provisional or liminal manner so as to allow their immediate manipulation and re-presentation if necessary.

Conclusion

The study of the field geologists' concerted and coordinated work provides not only a better understanding of the composition and organization of these gestural practices, their illocutionary function, and the role they play in advancing the participants' professional work; it demonstrates more generically that action in talk-in-interaction is not constrained to isolated forms of gesture, turns-at-talk, or bodily displays. Rather, these are built with regard to the ongoing courses of activity and the settings in which occasion their deployment. This

study contributes to our understanding of how talk-in-interaction and language more generally is reflexively built from a phenomenal world that is incrementally revealed as consequential, analyzable, and categorical through its systematic inclusion and iterative exposition in embodied and mobile action, as well as in the sequential organization of talk-in-interaction.

Opening-up Noticings: Making Activity Relevant via Co-present Features in Geological Practice

Introduction

In mundane interaction, where interactional work is conducted primarily through talk, the objects, events, or other states of affairs (SoAs) that interactants attend to are made co-present largely through their formulation in the stream of speech. Our current understanding of the practices that participants use for making relevant (and accessible) phenomena (objects, events, including prior talk, and other SoAs) in interaction is limited to their compositional and sequential description. For a range of such actions, described as 'noticings,' I will argue in this chapter that prior research has conflated the observable practice with what are in fact extra-situational aspects of its production, including reference to mental, non-public phenomena.

When we describe a noticing as having occurred in interaction, we currently lack consensus as to what the particular grounds are for describing the action-components (aural or embodied) that are sufficient or necessary for doing noticing. This is neither to say that previous studies have not explored instances where speakers do noticing, or revealed the situated practices that speakers accomplish noticing through, or that participants in these settings would not themselves describe the action as doing noticing, but rather that the analytical accounts given for what features in fact do noticing at best captures rather their accomplishment en total. The features thought to contribute to the illocutionary force of the action in turn are distributed over potentially numerous constructions, utterances, and responsible parties. A major obstacle in developing a more formal description for noticings is a lack of an account for how a) accessibility to the feature co-operates with its formulation, and b) how the situated activities in which the noticing is produced is mutually elaborated via

and with the noticing. As will be discussed below, prior investigations on noticings have instead tended to begin with the noticing as the origin for subsequent talk, without accounting for how it and subsequent actions are themselves accountable to what is observable in a given setting and how that fits into what the participants understand themselves to be doing.

The thrust of the discussion below problematizes not only our current description of noticing and questions whether a formal description is indeed useful--useful as a category of action, that is, in contrast to other tellings, e.g., reporting, announcing, informing, etc. Ultimately, the discussion and findings presented here suggest that a more grounded consideration of noticings can yield insights into formal aspects of the practice as well as the roles it plays as a member's practice. Indeed, adapting Garfinkel's aphorism, the discussion below and following analysis suggests that in spite of the "bad" analytical account that exists for noticing as a formal action, interactants nonetheless appear to have "good" interactional motives for accountably doing noticing. Interactants treat 'noticing' as a useful action-ascription for their and others own conduct, and, moreover, regularly act on what appear to be the routine perlocutionary attributes of the action (e.g., appearing "touched-off," being unmotivated, etc..

The range of phenomena analyzed in this chapter consist of the practices through which interactants make accessible and relevant some feature (e.g., object, event, prior talk, or other SoAs--including their aspectual consideration) in the co-present setting, that has not yet been taken as currently-relevant in the interaction. This chapter reports on such practices as used by novice and senior geologists as they conduct fieldwork in uneven, heterogeneous wilderness settings--settings that are often unfamiliar (especially to novice participants) as specifically geological settings. A major finding of the analysis is that a large domain of interactional work carried out when interactants do noticing--that is, make relevant a co-

present feature in the current setting--is reflexively accomplished with regard to not only how they make it accessible to others, but how it ultimately fits within what the participants take to be the tasks and activities that they are collaboratively accomplishing. Consequently, interactants operate on the significance attributed to the feature as a tacit means for opening new or significantly altered occasions of talk, focus, and activity in their project; put otherwise, speakers in these settings are rarely understood as directing others' attention to objects just for the purpose of doing so, especially when those objects are for the interactants ostensibly geological; rather, they orient to the actions, because they take whatever noticing, observation, or discovery it accomplishes to be relevant to what the speaker and co-participants do now or next.

Opening up noticings

In the following review I will discuss both the earliest work that contributed to our current conception of noticings as interactional practices in talk-in-interaction and how it has been used more recently in contemporary work. Throughout much of this discussion I will situate the discussion with regard to its application in geological fieldwork as well as comment on some of the limitations inherent in the descriptions of the practice--again with respect to geological fieldwork.

As defined by Schegloff (2007, p. 219), a "noticing" "...makes relevant some feature(s) of the setting, including prior talk, which may not have been previously taken as relevant." How the practice is defined here can be usefully decomposed into two complementary facets of their use: In doing noticing, interactants routinely do so by 1) (re)formulating (either via talk or otherwise) co-present feature(s) within a given setting, thus making its presence (or absence) accessible and actionable. 2) How that feature (or some aspect of it) is formulated more so, operates on that not previously being taken as relevant by the participants.

Sacks' description of noticings overlaps with Schegloff's in a number of ways. He describes noticings as utterances that display their being "touched off" either by prior talk, or by objects or events present or occurring in the interactants' immediate vicinity (i.e., "environmental noticings" (1995b, p.88; p.90)). An interpretive consequence of their production is in their appearing "occasioned" or opportunistically constructed from whatever motivated their production--and thus importantly not as simple nexts in a given sequence of talk. Accordingly, Sacks describes noticings as often disruptive to the current interaction, interceding ongoing courses of action and interrupting ongoing talk--even if that is from the noticer him or herself. Sacks suggests that it is through this occasioned production and disruptive placement of the action that contributes to how co-participants interpret the

noticer's apperception of the noticeable as being "just-noticed," "just-recognized," "just-realized," or "just-thought of": "[O]ne of the ways that one tends to go about showing that what one is asserting, one has just noticed, is to do it by reference to, e.g., an interruption of somebody else." (Sacks, 1995b, p. 90-91).

The focus on the provoked, touched-off, or occasioned production of the action manifests in their sequential production. Sacks remarks that the practice tends to indicate "...that they're not being placed in adjacency to some other utterance, are not responsive to it, shouldn't be figured out [only] by reference to what's been said, but have to do with things that have been proceeding in some independence of the sequence of talk." (Sacks, 1995b, p. 321). Schegloff (2007) similarly characterizes this sequentially disjunctive aspect of the practice, when he categorizes noticings, among other actions, as what he terms "retro-sequential objects" (ibid, p. 357). These consist of actions deployed in talk-in-interaction whose actionability stem from a "source/outcome" relationship, where the speaker positions their action as the "outcome" of some prior talk, event, or co-present object--that in actuality constitutes its "source." These actions, while possibly acting directly on prior talk, do so in a routinely oblique or orthogonal manner in ways often unanticipated by recipients, and do so often at the expense of previous course of action.

A difficulty arises in describing the practices analyzed in this chapter as "noticings," especially as noticings are operationalized in Sacks and Schegloff's early descriptions. The descriptions tend to conflate what is observably attested to in the practice with what is rather tacitly given in its use. Consequently, when later work more concretely operationalized sequential and turn-constructive features of the practice, it ran the risk of confusing observable features with what is rather tacitly accomplished.

In the discussion below, I will argue that the practices analyzed here do not share all of

the aspects previously attributed to noticings. Nevertheless, they do share enough of a family resemblance with the practice, and so warrant its consideration in this analysis. My interest in noticings, moreover, is how informing others on a given noticeable is reflexively constituted with seeing, hearing, or otherwise noticing that same noticeable. Noticing, that is, making relevant a co-present feature in the current setting, a feature that was previously not taken to be relevant, treats the co-present feature as both a resource as well as its initial problem: that is, the tacit work needed to shift what ostensibly is there in the co-present landscape for co-participants, but not yet collaboratively taken to be relevant to their ongoing project(s). Each of these facets can be analyzed in the practices investigated here. Prior to doing that though, I will briefly discuss how the characterizations associated with noticing are not relevant to this analysis.

A basic problem with previous descriptions of noticings is the aspects they take to be constitutive of the practice do not consistently align with the primary action we take to be occurring in the noticing, nor do they provide any insight into what might be recurrent, concrete, and readily recognizable features for the practice.

Describing the action as sequentially disjunctive or disruptive is of limited use when utterances are produced "out of the blue" in incipient states of talk where no immediate prior talk exists--states that are extremely common to participants' conduct during fieldwork. Even more problematic are instances where in observing something that a speaker sees follows and appears follows a prior utterance. The action ostensibly makes relevant a feature not previously taken as relevant but does so specifically in response to the prior turn. That placement may be incidental to the action. Nonetheless, the action in these instances is neither unmotivated nor evidently disruptive to a local sequence of talk. Given its "fit" with the current talk, whether the noticer just saw the object or only mentioned it here because of

the prior is not relevant to the participants' analysis of their respective conduct.

More generally problematic is the assumption that the telling is occasioned more by whatever the speaker sees or hears as opposed to being motivated by any ongoing project on the speaker's part. The participants studied here specifically come into the field with the purpose of describing the landscapes, terrain, and features they are formulating in their talk. Most if not all work-related formulations are rarely if ever "unmotivated" or "just noticed" as they are sought. Relatedly, both senior and novice participants have vested interest in anticipating and quickly describing geological structures and doing so competently as members of the geo-sciences, as a community of practice. Accordingly, the differences in the formulated significance of these objects is more graded than something just being relevant versus not relevant. Indeed, as will be readily apparent in the data below, much of the interactive work occasioned when participants make relevant co-present features is the incremental revealing of the feature as observable, noticeable, and actionable for the participants.

Turn-construction and action-formation similarly have not been shown to provide consistently stable features. Of the work that has explicitly focused on noticing as an interactional practice, analysis has described noticings produced entirely through embodied receipt, with and without change of state markers and other response cries, in various grammatical formats (i.e., as both statements and questions), both with and without evidential constructions (e.g., "this looks," "I see," etc.) , and so on. This isn't to say that these turn-constructive aspects do not help accomplish noticing, but at least as compared to similar instances in field geology data, they are necessary for but not entirely sufficient in accounting for the illocutionary function of the practice.

The alternative sources of guidance for this work are those studies that rather than

focused on isolated practices instead discussed more broadly how phenomena became perceptually relevant and that perception was organized interactively.

More problematic is how our previous conception of noticing, as a class of action, contrasts against alternative types of informings (e.g., announcing, reporting, telling, etc.). As stated above, noticings are distinct because in their production they closely tie a speaker registering the presence of a feature with his or her informing others on that feature.

Moreover, it makes those two aspects conditional on one other. As a point of contrast: When one announces a pregnancy or reports laboratory test results, for instance, we tend to presume that the speaker has already known about the information well in advance of the telling itself, and furthermore, the talk conveyed in the telling is the reformulation of prior talk(s) and the outcome of prior activities--none of which is the recipient necessarily privy to outside the current telling. Noticings, as they have been previously treated, however, presume a more proximal relationship between the noticer--and by extension the recipient--and the noticeable. Our vernacular understanding of noticing presupposes that the noticing is deployed closely in time and space with presence and perceptibility of the noticeable itself. Most often that it comes as the result of the noticer having just perceived the noticeable. This in turn include other assumptions: e.g., the formulated noticing is the first formulation by the speaker for the recipient(s); the noticeable only just became available to the noticer, and thereby is being made accessible to the recipient. These inferences have consequences for our analysis of noticings as actions and should be acknowledged in better understanding the full range of situated practices interactants have for informing themselves and others.

While the physical and temporal proximity between noticer, noticeable, and recipient are indeed recurrent and relatively stable aspects of the practices investigated here, many of features ascribed to noticings are limited as they rely on what are in fact incidental features of

the action as a type of telling, and is especially problematic when applied to the practices in the field geology data, which appear to make little distinction between their noticing, announcing, reporting, or inquiring on a given object or feature in the landscape. While participants do not know in advance the features that they will find, they do draw upon the inventories of training, experiences, and knowledge they bring to the field for describing those. As a result, many tellings we see in this data are in a sense a mixture of novel and given formulations.

I can expand on this discussion some with regard to its application to the participants conducting geological fieldwork as well as consider some of the issues that appear in analyzing the collected instances: For feature(s) to be co-present in the current setting--but not yet taken as relevant by the geologists--we take the practitioners to be operating on the feature(s) as having some perceptual and thus evidential grounding, putatively accessible for both the speaker and others. Moreover, that grounding is treated as having some independence of its formulation in the talk. Moreover, in making that formulated feature¹⁰ now relevant, the participants also operate on it as not having been previously taken as relevant in the just prior interaction. The noticing thus effects two simultaneous changes in the participants' mutual foci of attention: 1) attention towards the newly formulated feature and 2) attention towards the newly reconstituted activity as a result of that feature. Moreover, the practice presupposes that the formulated feature provides a warrant for these changes--a warrant that ostensibly recognizable as such. Where successful in the corpus, we routinely see the formulated features emerge through the course of the interaction, eventually surfacing as geologically- and activity-relevant in their presence or absence.

¹⁰ In formulating a feature, the speaker(s) can direct their interlocutors' attention to either wholly new and previously unformulated "things" or "places" or alternatively to their aspectual consideration, that is, "seeing them as." (Wittgenstein, 1972, p. 304)

In field geology, the practices that practitioners use in making accessible and relevant to others specifically geological features in the co-present landscape display a number of the hallmarks attributed to noticings as interactional practices as described by Schegloff and others. In following analysis, I will discuss how the notability of the referents arises apart from formulation in the talk.

In most mundane interaction where noticings occur, the significance of the noticeable is more or less formulated to its fullest extent in its first instance (though see Woods). In contrast, in the field geology data, the features formulated in the participants' talk rather emerge through numerous reformulations in the interaction. When a geologist offers a formulation of what is tentatively perceivable to him or her--and by extension others, the relevance of the formulated feature is not always immediately identifiable to the participants with reference to the co-present landscape or what they take themselves to be doing in it. Moreover even when referring to a rock the speaker is holding, he or she can refer to it in terms of its appearance, its mineral make-up, the processes that created it, the 'provenance' or location it was extracted from, the participant who extracted it, or its eventual use. As such, geologists regularly embed their formulated objects in different formulated contexts and in doing so, deploy a range of indexical expressions, e.g., "this," "that," "here," etc., in resolving for what the field geologists is a recurrent analytical problem, namely how different features and phenomena fit into their ongoing, situated investigation of the landscape. As a result, the ultimate significance assigned to various features and terrain unfold in determining their placement in their ongoing courses of action.

The practices analyzed here are actionable precisely because of their use in either opening or closing particular situational, locative, and/or sequential ambiguities. This process is interpreted and reinterpreted with regard to the ongoing activity, setting, or context that

occasions the practice. Accordingly, the ambiguity engendered by indexical expressions selects recipients to search for what referent is invoked in "Is that too big?" (excerpt 4.6, line 1). Making that assessment, however, requires the activity in which the sample will eventually processed for accessing the appropriate criteria in making that assessment. Similarly, Melinda's "I'm not seeing a lot of hornblende in that" (excerpt 4.7, line 1) and "not seeing a lot of hornblende though" (line 10) also deictically embed the assessment, "not...a lot of hornblende," in the object, "that." She also effectively embed herself as the deictic centre for those assessments as both an observer and assessor. While one set of practices formulate the concrete aspects of the participants' interactional space, the notable and assessable (and thus actionable) character of the formulated observable is provided in part by the activities that the participants are pursuing. They play a constitutive role in the how the participants build action.

Methods

This data corpus consists of four separate video-documented ethnographic visits to field-based projects involving field geologists. The first was performed by Charles Goodwin over the course of four days in the Summer of 2011 in and around Yellowstone National Park. This fieldwork consisted a Research Experience for Undergraduates (REU) project led by David Mogk (Montana State University) and Darrell Henry (Louisiana State University) that brought advanced undergraduates into the field on an active research study to gain research experience. The second was conducted by the author over the course of five days in the Summer of 2014 in the Madison River Valley, Montana. This data consist of an undergraduate geology capstone field course required of senior students before graduation. The study participants included three instructors, two graduate assistants, and 32 senior undergraduate students. The last ethnography was conducted by Charles Goodwin and the author over the span of five days each in the Summer of 2014 and 2015 in and around the Owens Valley, California. These materials consist of a National Science Foundation (NSF) funded project, organized by Matty Mookerjee (Sonoma State University, California) and Basil Tikoff (University of Wisconsin, Madison) and consists of a multi-part collaboration bringing together geo-scientists from different sub-disciplines alongside cyber- and information scientists for the purpose of developing hardware, software solutions and large-scale database architectures to create, upload, and make available digital data sets for the field-based geosciences.

In following the participants, where possible, the video-recordings were made continuously without cuts so as gain a "micro-longitudinal" perspective on how the participants' daily and multi-daily routines were developed with reference to their situated reasoning practices occurring therein. After the data were collected and brought back from

the field, the videos were transcribed and analyzed using conversation analysis (Sacks, Schegloff, & Jefferson, 1974) with a particular focus on participants use of embodied action and gesture (Goodwin, 2000; 2010; Mondada, 2013).

Analysis

In fieldwork settings, several aspects of the analyzed practices become readily apparent and thus useful to explicate ahead of analyzing them:

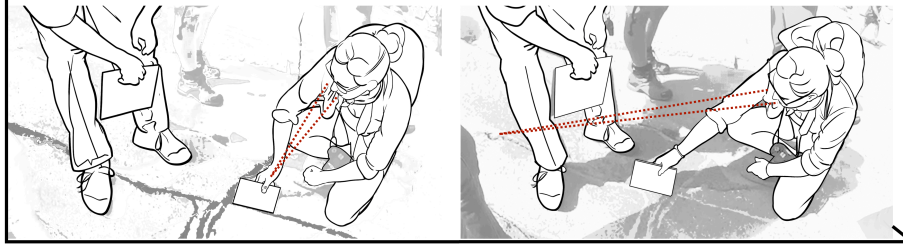
- 1) Participants' awareness and assessment of the co-present objects or phenomena do not begin, depend on, or end with their initial articulation in speech.
- 2) Moreover, asserting in talk that some co-present feature is relevant or notable does not much as select 'nexts' from a recipient, as it occasions subsequent members' analyses of the feature (as articulated) on whether it remains relevant or notable against more extended considerations. These occasions routinely envelope (and systematically implicate) other parties in that consideration.

A consideration of these aspects en total suggests that the structural features of the practice (i.e., participants' perception of the notable feature, its articulation in the talk, their recognition of its notability, and its ultimate accountability to the ongoing projects as actionable items) emerge asynchronously from one another. By this, I mean that in the field geology, rarely do we see utterances that fully encapsulate a fully recognizable articulation of the noticeable and the full extent of its significance for others. I will examine the excerpts below as examples of how the relevance of a co-present feature emerges incrementally in the interaction, and not even necessarily through the talk.

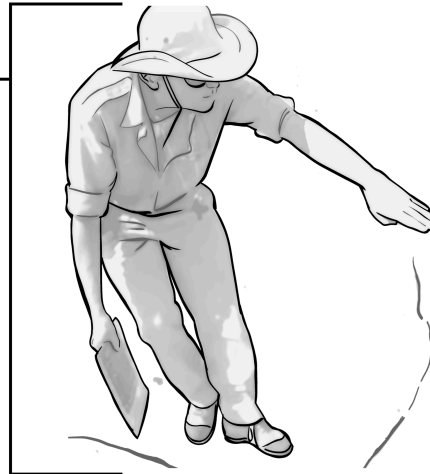
In excerpt 1, I return to an example from the previous chapter on diagrammatic gesture, where Ally and Steve are inspecting the various intrusions that run through the surface of a large exposed igneous rock. I want to direct the reader's attention specifically to Steve's talk in line 43. While the utterance displays his having noticed something, "it is dipping this way," it also displays the recognition that this is not the first instance of this assertion.

36 Steve: bcuz it's actually sitting- if it's sitting in like this
 37 and over that way. [it might create [that separation
 38 Ally: yeah::: [cuz [based on this being

39 (1.8)



40 Ally: if that's all one plane,=which
 42 (6.2)
 43 Steve: it is dipping this way isn't it
 44 Steve: you can see down there
 45 (1.)
 46 Ally: yeah
 47 (.8)
 48 Ally: oh that's cool



Excerpt 1: Recognizing notability prior to formulation in talk

Steve's utterance displays its being built from his participants' prior work, especially from Ally's diagrammatic rendering of the angle of the intrusion (line 38) and how that contradicted the angle he asserted and depicted earlier (not shown here; see chapter 4, Excerpt 4a). The manner in which his turn acknowledges that work (e.g., with its stress on the copula, its tag question, etc.), operates on Ally's prior diagrammatic depiction as having previously provided proof of what he now realizes to be the case with the intrusion--it dipping in a different direction--a significance that he had previously not noticed.

The notability of the co-present object (or some aspect of it) emerges prior to its formulation in the talk. Moreover, in analyzing that emergence, we should appreciate the limited ways in which it shows itself to be and not to be sequentially built with respect to the

prior interaction: Even though Steve's utterance in 43 shows receipt of Sheryl's previously articulated angle, the most immediate antecedent to his utterance is not the depiction itself; rather, the most immediate antecedent occurs in the preceding 6.8 second gap, where we see Steve stand up, look down the full length of the intrusion, and only then recognize with a point to where the angle is exposed and thus visible. His utterance in line 43, while displaying its being built with regard to Ally's prior depiction, is itself rather coordinated or occasioned on his own recognition of the apparent dip of the intrusion.

There appears some disassociation between the action that shows a recognition of its position within a sequence of actions while also demonstrating its own perceptual development. Even where the actual dip of the intrusion fully emerges in the talk, it has less consequence for how the participants sequence their talk, than it does for how they coordinate their subsequent orientation and movement with regard to the material surround: We can see that while Steve's observation shows receipt of Ally's depicted angle, it is given minimal (and delayed) receipt by Ally (line 46). Moreover, Steve does not orient toward his interlocutor, but rather immediately transitions to building off the relevance of this new feature (new for him), visibly examining the full length of intrusion, before noting his own observation of where the angle can also be seen in line 44: "you can see down there." How Ally responds to Steve's assertion is informative of the necessarily perceptually-grounded ways in which the noticeable becomes actionable: As Ally produces her "yeah" she looks to the surface that she and Steve previously examined, and not where he currently points (i.e., "down there."). Her agreement in line 46 thusly works more as a receipt of Steve's re-assertion, than it does of his novel assertion. When she does look to where Steve points just prior to line 48, we see a much more upgraded "Oh that's cool-you can see it right there."

What is pursued in making a given co-present feature relevant for others--a feature that

was not previously taken as relevant--is not so much a sought-after "next" in the talk, but rather a recipient's displayed (re)orientation to that feature in the co-present material surround. What follows in the talk then emerges from their recipient's respective analysis of that feature. Any agreement or disagreement that emerges between their respective positions appears less as a function of sequence than it does a synthesis of their own occasioned and independent analyses of the feature and its relevance to their ongoing activity. While the utterances that follow next from these points can and often do sequence from prior turns-at-talk, simply doing so is not adequate proof of a competent receipt of the feature or aspect the prior speaker has now made relevant.

In contrast, in mundane interaction where the work of producing action is carried out primarily in the talk (whether by telephone or face-to-face), opportunistically "noticing" something via its formulation in talk is the primary means by which phenomena extraneous to the talk are invoked into the talk as foci of attention. In such contexts, participants may have different methods and motives for distinguishing these from other tellings (reporting, announcing, story-telling, etc). In geological fieldwork, however, both novice and senior practitioners operate on the landscape, terrain, and features as "pre-formulated" (that is, as tentatively asserted tokens of some geological type, each with its own classificatory, mathematical, and geometric description)--even if these are not actually recognized as such.¹¹ Participants operate on the world as "pre-formulated" even if we as analysts recognize that this is also an accomplishment of their conduct and interaction. In turn, this mutual orientation to a tentatively pre-formulated world becomes a resource for building action and coordinating work in the interaction. The excerpt above shows that the process by which a

¹¹ By this, I mean that the practitioner presumes there to be a geological description appropriate for whatever is present, independent of their current attempt to describe it.

speaker makes accessible and relevant to others specific co-present phenomena need not always be accomplished via its formulation in talk, even if doing so is one projected outcome of their work--co-present objects in the field can be noticed and actionable prior to its availability for parsing in the talk.

Even after some co-present object has been made accessible and relevant in talk via a noticing or other telling, its relevance and significance ultimately depends on its subsequent uptake. Adequately assessing those aspects of the action or the formulated object, however, extends beyond the grounds on which it is initially formulated--not because the initial formulation is incorrect, but because its notability rests on other alternative formulations of the object that must also be true. This can be seen in the Excerpt 1a. Two pieces of ethnographic information are relevant to the analysis. The first is regarding Matt's eventual description of the rock's composition and it containing garnet in lines 19 and 20. Garnet is a diagnostic mineral useful for dating the formation of different bodies of rock. It is relatively rare, however, in the rock, and thus notable when discovered in sufficient quantities. The second aspect of the interaction is in regards to the evident resistance that Darrell takes in his turns-at-talk in lines 9 to 11: Dave and Darrell, as the senior geologists and lead researchers on this study, are likely concerned about the allocation of everyone's labor. While one of the larger goals for their project is in refining prior maps of this area with more fine-grained boundaries between various rock formations, their locations, and the outline of their contacts, accomplishing requires more than just mapping. The geologists also have to identify and date the different formations, which in turn requires their collecting and transporting rock samples of sufficient quantity back to the laboratory. Only so much rock can be collected and physically brought back, and committing labor to extracting rock in one location represents a lost opportunity for other locations. If a small area has a lot of heterogeneity, there is a cost in

continuously splitting that into different formations. The action begins below, when Matt, alerts Darrell, the instructor and co-lead investigator, to a particular relevance for the rock sample Matt is inspecting, "this looks really different from that," "that" being the rock where Darrell is working.

```

01 Matt: oooooh
02 Matt: ^hey, darrell.
03      (.4)
04 Matt: this looks rea::lly different fro:m tha::t,
05      (.8)
06 Darrell: ^okay:,
07      (1.)
08 Darrell: well:,
09      =we've see:n a lot of heterogeneity,
10      (.)
11 Darrell: o:ver this sma::ll body.

12      (.)
13 Matt: right,=
14      (.)
15 Matt: <but there's
16      (.)
17 Matt: ma:y::be::,
18      (1.)
19 Matt: like, there's less a percent of biotite.
20      <and> garnet.
21      (.4)
22 Darrell: (there-)=you see ga:rnet?
23      (.6)
24 Matt: i think so:::?
25      (1.)
26 Darrell: wo::w.

```



Excerpt 2a: Negotiating on the notability of referents

Two aspects of this interaction stand out for the purposes of the analysis: 1) the particular form of utterance Matt uses for formulating the object, and 2) the initial resistance (or more precisely equivocation) that Darrell responds with in lines 6 through 11.

Compare the various ways that Matt (re)formulates the rock in lines 1-4 and later in lines 13-20 after Darrell's response. Whereas in lines 1-4, Matt formulates that the rock he is holding is "looks really different from that"--that being the rock where Darrell stands, after Dave equivocates on its significance, Matt shifts to the terminology they would use for describing the rock¹² compositions in their field forms, specifying both its exact composition

¹² That is, the specific terminology used in the forms or printouts the geologists use for recording rock composition: "less than 01% biotite"

as well as the presence of garnet, a diagnostic mineral useful for dating rock formation. While his initial formulation in lines 1-4 is in comparison rather unspecified, it nevertheless characterizes the rock in the most 'actionable' terms. We can in fact see this reflected in how Darrell subsequently reformulates Matt's discovery for Dave, the other lead geologist, in lines 14 to 15 in the excerpt below. Rather than being an issue of specificity or granularity in the chosen formulation, the choices appear made with regard to what is actionable in the given talk.

If Matt's initial characterization of the rock captured that salience, we can ask why and how that is reformulated in Matt's reformulation in lines 13-20:

```

01 Matt: ooooooh
02 Matt: ^hey, darrell.
03      (.4)
04 Matt: this looks rea::lly different fro:m tha::t,
05      (.8)
06 Darrell: ^okay:,
07      (1.)
08 Darrell: well:,
09      =we've see:n a lot of heterogeneity,
10      (.)
11 Darrell: o:ver this sma::ll body.
12      (.)

```

```

13 Matt: right,=
14      (. )
15 Matt: <but there's
16      (. )
17 Matt: may::be::,
18      (1.)
19 Matt: like, there's less a percent of biotite.
20      <and> garnet.

```

```

21      (.4)
22 Darrell: (there-)=you see ga:rnet?
23      (.6)
24 Matt: i think so:::?
25      (1.)
26 Darrell: w@:w.

```



Excerpt 2b: Reformulating the significance of referents

Matt reformulates the rock in lines 13-20 in part due to Darrell's equivocation in lines 6-11. While Darrell's resistance to the notability of Matt's rock certainly may in part be the result of his assessment of Matt's relative expertise, his response does not doubt the rock being different, nor seek why Matt considers it to be so different; rather it dis-aligns with the projected significance of the feature formulated by Matt (that is, collecting a sufficient samples of the rock for laboratory analysis), and does so not by disagreeing with its formulation but rather equivocating on its significance in this setting: "Well, we've seen a lot

of heterogeneity over this small body." In addition to its prefacing, Darrell effectively makes "really different" synonymous with "a lot of heterogeneity" that since "[they]'ve seen," is thus not news and thus not significant or actionable. We see, however, in response to Matt's revealing the exact composition of the rock and its containing garnet, that Matt's earlier utterance did in fact formulate an actionable feature in the world--one that Darrell did not anticipate. Moreover, this is endogenously negotiated and incrementally revealed for each co-participant in the course of of talk.

The initial contrast between the relevance that each participant attributes stems from a consideration of not just the prior sequence of talk, but how the given formulation projects a subsequent course of action. Each response, while sequenced from one another, also stems from what is "observable" about the feature in this setting for each participant. For Matt the rock is observably different and thus worthy of mapping, while for Darrell a lot of heterogeneity is observable and thus not worthy of mapping.

The participants' selection of their respective formulations and the relationship that develops between them, stem in part from the speakers emerging orientation towards the alternative formulations as resources for conducting the interaction and coordinating their collaborative work. Moreover, Matt's displayed competency is in effect demonstrated through his selection of the alternative formulations presumably in how they agree with and support his initial utterance. As we see here in excerpt 2 and later in the analysis, this is not only relevant in how subsequent sequences of talk are revealed subsequent to the noticing, but also what participants project as actually accomplishable via the noticing. Put otherwise, making accessible and relevant some co-present feature in the talk routinely occasion extended courses of action deployed towards successfully resolving the problem or opportunity presented in the noticing. Another final aspect of this excerpt that is recurrent in the practices

analyzed in this paper is how subsequent speakers use equivocation in resisting the relevance of the initial formulation.

The notability of a given object or phenomena is in many ways a conclusion reached by an interactant via his or her understanding how the formulation fits within a particular discursive context, namely its facilitating or undermining a given course of action, task, or activity. In geological fieldwork, notability is determined by the larger demands made upon the interactants in terms of what inscriptions and materials they are expected to produce in their coordinated work. In the same way that noticing something might act as a vehicle for other actions (e.g., complaining), making relevant co-present features and bringing those to others' attention is operated along the particular trajectories of the task and activity in which the participants are engaged. How a given feature is made relevant can in turn be understood along quite extended activities.

Activities like sequences of talk are temporal structured: they have a beginning, an end, and are internally organized, with points in between that mark progression within. Activities are further structured according to a range of continuous and discrete values that participants ascribe to the progressivity, especially if there is an expected, assessable outcome. That outcome in turn may force an ad-hoc reassessment of the activity. Activities may further be embedded within a series of activities, and as such are analyzable with regard to these more distant horizons. The excerpt below provides a simple example of this. Here, an undergraduate researcher, Mark, is breaking apart a rock sample when he holds the rock up to two more senior geologists, Darrell and Terry, and asks his question (line 1).

Excerpt 3: Situating objects within different activities

Cumulatively, Mark, Darrell, and Terry assess the rock sample as being "too big." We see this in the presupposition displayed in Mark's question (line 1) and Darrell and Terry's



01 ==> Mark: is that too: big?
02 Terry: ye:s.
03 Darrell: =ye:s.
04 ==> Dave: it's too bi:g for the jaw:: cru:sher:,
05 =but we do want cut a thi::n section.
06 (2.2)
07 Mark: [i got a lot of
08 Dave: [uh::- no:: knock it dow:n some more::.
09 Mark: yeah



responses (lines 2 and 3). The other senior geologist Dave's utterance in line 04 supports the prior speakers' assessments while also elaborating on what the sample is "too big" for--the jaw crusher. Speaking collectively with "we" he juxtaposes that with their also 'wanting' a sample for a thin section as well.¹³

Dave's lines 4 and 5 invoke the alternative uses for the rock sample Mark is preparing. What is relevant in this excerpt for the larger analysis is the alternative uses or destinations that Matt invokes with regards to whether his current work, i.e., the breaking of this sample, is completed or not.¹⁴ This in turn would suggest that Mark, Darrell, and Terry's assessments, or formulation of the sample is also deployed and analyzed with regard to its subsequent use. The consequence of those formulations and their responses is for progression of the activity that they are being deployed within. It is not just that the rock is "too big," but rather that it is

¹³ The jaw crusher is a laboratory machine used by the geologists for crushing rock samples into fine particulate for mineral analysis. Its samples can only be "too big" for fitting into the machine. A "thin section" is a thinly saw-cut rock sample mounted on a slide for microscopic analysis. Its samples in contrast can also be 'too small' making them unsafe to cut with the rock-saw.

¹⁴ Mark's question could have indeed been "purely" information seeking; students often do not have much experience processing samples in the lab and so are unclear about the appropriate sizes for the samples. Nevertheless, the participants use future activities as a means for assessing the rock and responding to his question.

still "too big." As such, Mark resumes breaking apart the sample.

The observable and assessable quality of the talk and its subsequent formulation as "too big" is interrogated by the co-participants with regard to its suitability to the larger activities it is embedded within. As such, while the turn is certainly a first-action as its responses are second-actions, their assessable character is deployed not only with regard to their sequential structure but to their consequence for the activity. As such they can be likened to something approximating terminal exchanges, sequences whose consequence is in transforming the current activity under way into something else.

Notability is not decided by fiat, either by one speaker or in one utterance but relies on the particular divisions of labor that the interactants bring to talk: In mundane talk, noticings are typically limited tellings and routinely formulated for the purpose of prompting a recipient to elaborate as the party capable of and responsible for knowing about the noticeable. As used in this corpus, however, the division between participants in their respective knowledge of and responsibility for a given object or range of phenomena is simultaneously more nuanced and its consequences more stark.

In line with the actions described in the literature above, the practices analyzed here effect two complementary transformations in the current interaction. In making relevant (and accessible) some co-present feature(s) in the current setting--they operate on these feature as also having not yet been taken as relevant by either the speaker or others. The practices analyzed in this corpus that accomplish this vary in their appearance, however; although they routinely make finite claims about co-present objects, phenomena, or other SoAs in the landscape, they can do so by assertion (e.g., "Here's the first contact"), interrogative (e.g., "Is that too big?"), or evidential marking (e.g., "I see garnet"). Nevertheless, even where we see the practice ostensibly assert information, actors nonetheless act on them as a means for

gathering input from co-participants on the feature in the subsequent talk--specifically as potentially activity-relevant objects (i.e., a geologically useful objects or phenomena for sampling, measuring, or otherwise recording). In spite of the differences in the appearance of the various practices (as well as their co-present referents), I will argue below that they are routinely operated on by speakers (and recipients) as initiating moves in possibly extended courses of action, all centered on the question of how to act on the formulated feature(s).

When interactants make co-present feature(s) relevant and accessible to others, we see those formulated features routinely operated on as to whether they are indeed relevant to co-participants' immediate or projected courses of action. Their significance is rarely presumed as given or obvious, however, and rather occasion others' mutual scrutiny of the feature within their collaborative project. In line with this observation, the practice does not so much as select 'nexts' from recipients as they occasion others' mutual attention of and co-elaboration on the formulated feature and its significance. We can see this in the excerpt below where student researchers are inspecting and cataloguing samples when Karl announces a finding: "I see garnets."

01 Karl: (I) see garnets,
02 A=> Laila: yeah are there garnets in this?
03 Laila: i thought i saw'[em
04 B=> Dave: [i haven't seen'em yet
05 but if- if you see'em,
06 that would be significant
07 C=> Terry: see what?=garnets?
08 (9.6)
09 Laila: looks like it to me,
10 D=> Mel: yeah similar to:: [()
11 Laila: [i think it is,.
12 (3.9)
13 Karl: [(did-)
14 Laila: [we think we found some garnets.
15 (.)
16 Karl: i think so too
17 (1.9)
18 Mel: there's some on the surface
19 that you're sitting [on (.) [underneath,
20 Laila: [yeah [underneath,
21 Dave: [let me just (see)] have a look here
22 Mel: [(your rock)]
23 Mel: and then there's one over this
24 Mel: there's uh b-
25 yeah there's like really small ones
26 Laila: (you'll see like) uh
27 (one that doesn't have a () but ()
28 Laila: so about [(.) one to two millimeters
29 Terry: [right in here?
30 Dave: yup nice little red garnets
31 Dave: yeah
32 Mel: ((lil')[)
33 E=> Matt: [you guys are seeing garnets in this?
34 (XXX): (big time::)
35 (10.)
36 Karl: would you say one millimeter or less?
37 (.)
38 Laila: he said one to two
39 Dave: yeah
40 Mel: aren't they a little bit bigger
41 (.)
42 Laila: but they're not [necessarily ()
43 Matt: [()
44 Laila: they're just little ()
45 Mel: yeah
46 (1.9)
47 Dave: well:::, damn:::
48 Dave: that's pretty cool

Excerpt 4: Cultivating recognizable assessables

The manner in which Karl constructs his utterance in line 1--calling out "I see garnets!" while closely examining the sample he is holding through his eye-loupe--is significant in two aspects for how it allows for and constrains others' participation in the subsequent talk: He neither a) overtly selects a next speaker nor can the garnet he sees be co-experienced by others (without his handing the sample to another). As a result, subsequent actions are largely understood as self-selected and, moreover, operate not on the question of whether Karl can see garnet but whether garnet is present for the purposes of the group's collaborative project. We can examine his interlocutors' subsequent actions for how each selectively operates on Karl's action as either a prior turn-at-talk versus occasioning their own access to the

formulated feature. We can see this first in Laila's turns in lines 2-3.

Laila's initial utterance co-operates on both the sequential position of Karl's prior and the feature(s) it formulates--particularly towards their verifiable co-presence: Her initial "yeah" ties to the prior via agreement, effectively repositioning it as a warrant for her own question "are there garnets in this?" Laila's talk, however, does not project a stance on what Karl is seeing through his eye-loupe. Rather, it registers her own experience of potentially co-present garnet independently of Karl's--that is, via her having "thought" seeing them (lines 3-4). As a result, similar to Steve's utterance from Excerpt 1, line 43 ("It is dipping this way, isn't it?"), Laila's talk displays its limitedly operating on Karl's prior via her own previously unarticulated sightings of the garnet. Moreover, like Karl's turn, Laila's turn is directed more toward the entire group, than it is to Karl as the prior speaker.

In initiating her action as a question, Laila's utterance reveals some of the interactional parameters that Karl's initial assertion works within, as a type of noticing, specifically with reference to what it putatively asserts (and pursues) about the feature as publicly actionable object. "Garnet," in being useful diagnostic mineral as well as relatively rare in the rock provides participants what Goodwin describes described as a recognitional (2003), an object immediately assessable for its significance on bare mention alone. In asserting the possibility of there being garnet, the participants open and operate with a domain of uncertainty, whose resolution ends with either determining whether people are in fact seeing garnet. Laila's question essentially underscores the inquiry pursued via Karl's noticing.

Dave's response in lines 4-6 "I haven't seen'em yet...but if- if you see'em, that would be significant" not only treats the presence of garnet as indeed 'news,' but more significantly explicates it being "significant. His utterance elegantly responds to Laila's question while expanding on its relevance for the other co-participants, specifically in relation to their

collaborative work.

The question of whether people are in fact seeing garnet becomes the immediate activity for numerous participants, each of whom act on that--whether that involves re-locating the garnet they had seen in the rock (see Laila and Melinda's talk, lines 9-14, 18-20, 22-28), re-examining their own (see Karl's talk, line 16), examining another's sample for themselves (as Terry and Matt do around lines 29 and 33, respectively), or bringing samples to Dave for verification, as we see in lines 21, "Let me just (see) have a look here," and 30-31--"yup, nice little red garnets, yeah." And where after the participants either tacitly or explicitly agree on finding an actionable feature, the talk turns to 'next tasks' within the greater activity, with that here in excerpt # being finding garnets of sufficient size (lines 36-45). Altogether, making relevant seeing the garnet there and then opens a spatial and temporal domain of scrutiny as well as an inventory of reportable features that fall within its purview and in doing so provides those in the interaction and the object itself as resources for building not just subsequent actions within the the task but within the interaction.

Within field geology, we see that the practice of making relevant features in the co-present setting function as a means for occasioning activity on that feature, specifically with regard to the participants' mutual project. Accordingly, when we analyze the placement of the actions that these participants use for formulating some feature(s) and how these are then accumulated over the course of the activity, we simultaneously see how they organize the successful completion of their tasks with their coordinate movement and work in the surrounding landscape as interactants between their observing, finding, and moving towards and away from co-present features and the procedural, documentary work they use in cataloguing and measuring those features as scientific objects. In the field geology data, the practice acts as a means for occasioning the talk and interaction necessary for accomplishing

that work.

The practices discussed here are fundamentally deployed towards occasioning transformations in a given spate of interaction and activity. As a result, the practices analyzed here appear less to effect change in a next turn than they do in the over-arching activity within which the participants are engaged. As such, they do not select next speakers for relatively circumscribed nexts as they open spates of talk within an activity for considering initiating a new or altered phase in the ongoing project. Subsequent speakers then agree or disagree on whether the formulated feature is significant and whether that significance (and by proxy) initial formulation occasions a new or altered phase in their ongoing courses of action. This can be seen in the excerpt below where three geology students are identifying, mapping, and measuring the regional folding of different rock types over a large area for their capstone course. The rock consists of different rocks that were in the geologic past deposited in layers of sedimentary rock that were then buried far below the earth's surface and deformed and metamorphosed (i.e., undergoing chemical change, recrystallization, being folded, twisted, and overturned by the extreme heat and pressures found deep in the earth's crust, before resurfacing and being exposed in outcrops in the most recent geological era. Just prior to the excerpt, they had departed from an outcrop along a ridge they identified as quartzite, transversed the shallow valley between two ridges, making observations of the float in the valley, while also surveying the immediate ground for any abrupt change in the bedrock--that is, the next or "first" contact between the previous quartzite and whatever comprises the new rock. In the excerpt below, we can see this where Kyle announces¹⁵

¹⁵ Note that I am using the term in the vernacular and not analytical sense

"Here's the first contact."¹⁶

01 Kyle: here's the first contact
02 for sure
03 (p)
04 Kyle: outcropping at least
05 (p)
06 (Dre): (it's all just-) ()
07 (p)
08 Dre: it's all just fuckin quartz float
09 Kyle: here's the first outcrop
10 (p)
11 Dre: phyllite
12 Tyler: phyllite
13 Dre: >yep<
14 Tyler: (crop)
15 Kyle: so i bet that whole thing's phyllite
16 (p)
17 Dre: [(i bet it is)
18 Kyle: [basically
19 we might have t-
20 we might dash it a little bit below
21 (p)
22 Dre: yeah yeah=
23 Kyle: =could be
24 Dre: (it's ()) kinda coming [down
25 Kyle: [but who know-
26 since it's metamorphic
27 it could literally be any

Excerpt 5a: Situating features within time and place

Several actions and changes in the participants' formation vis-a-vis their material surround are occasioned on Kyle's utterance: Whereas Drew and Tyler previously examined a nearby piece of float, they now look toward the ground below their feet and state the composition of the new rock: "phyllite"; 2) Kyle follows on this describing an inference of what he takes the composition of the terrain they just transected to be; finally, we see 3) Drew propose "let's pin."--that is, stopping at this current location while articulating some of the procedures they will do at that location in lines 24-25: "I'll make a new locality, take a bunch of strikes and dips."

As a coordinated accomplishment, we see Kyle's initial utterance occasion a shift in his

¹⁶ A "contact" is any evident change in the folds and their rock types in the bedrock below the soil. As we can see in the transcript, the contact is where the quartzite that they were previously walking abruptly changes to phyllite.

own and his co-participants' individual and collective activity, their proximal task, and movement--from moving across the terrain to stopping at the co-present outcrop, to the inscriptive practices for measuring, documenting, and describing various geological features of that outcrop. The course of action initiated via Kyle's utterance invoking a co-present feature as not only accessible but relevant to his co-participants' progresses forward by seeking and coordinating mutual attention towards what the speaker takes to be an ostensibly significant feature for their ongoing project; moreover, his action takes that feature to not have been publicly accounted for yet in their current courses of action.

The composition of the action displays the degree that its articulation via speakers' talk, body, and orientation operate on accessibility of the co-present feature in both its production and interlocutory efficacy: Kyle's initial talk (lines 1-4) receives no uptake from his co-participants--as Drew and Tyler were oriented away from Kyle towards the rock they had examined up until Drew's talk in lines 8-9: "it's all just fuckin' quartz float." Kyle reasserts his utterance again in line 9, "Here's the first contact," at the earliest opportunity of having the others' reciprocity. In doing so, Kyle simultaneously turns his body towards the others so as to align it with the length of the contact, thereby layering multiple actions (aural, embodied, and mobile) each co-operating on one other in projecting the contact as a more visible and publicly accessible geological feature.

Drew and Tyler's subsequent actions--that is, their coordinated shift from examining nearby float to then looking toward the ground and exclaiming "phyllite," while operating on the course of action launched by Kyle's initial utterance, do not in fact work as responses in the same way that an acceptance or rejection might towards an invitation. Instead, their accountability as actions stems not solely from their verbal articulation (though that can certainly spell success or defeat for the projected enterprise). Rather, that enterprise (and

indeed their composition) begins with the speakers' reorientation towards the attended-to feature specifically for the purpose of ratifying and elaborating it as an accountable instance of not only a geologically-relevant feature but an immediately or proximally activity-relevant one. That course of action is provided for by the outcome of their analysis of the bedrock-- which was itself occasioned by Kyle's prior--more so than it was selected.

Kyle's subsequent expansion (lines 15 thru 27) implicitly accepts the classification of "phyllite," but does so 1) in a retelling of the ground they just walked over ("so I bet that whole thing's phyllite") and a proposal of how they might document that in their field-notes (we might dash it a little bit below"). The notability of Kyle's utterance is observed via a constellation of different features, including but not limited to the utterance, the presence of recipient(s) who can look, the orientation of his body in space, as well as the expectation that the rock changes at the contact. The responses that follow from Kyle's assertion recognize their subsequent placement to it as a prior assertion, and do so in their articulating what was otherwise unarticulated in Kyle's utterance. They are, however, themselves an outcome of their speakers' analysis, which was in turn occasioned by Kyle's prior. The organization is less one turn being about selecting the form and extent of a next turn-at-talk, and more one of one turn formulating an outcome on the speakers' part which in turn occasions the opportunity for his recipients to reach the same conclusion, if possible.

Kyle's initial utterance launches his work in coordinating he and participants' arrival at this location, bringing their attention to the contact in particular as the operable feature. That initial attempt in making relevant the contact functions by occasioning subsequent expansion, with each expansion being analyzed for its occasioning further expansions. These expansions are managed sporadically via sequences of talk, but they are ultimately accountable towards and from their co-present features, and as such are operated particularly in relation to their

facilitating the participants' ongoing activity.

09 Dre: is that pushed up then?
10 (p.)
11 Dre: no:::=
12 Tyler: =[they're all dipping)
13 Dre: =[((these over here are [pretty) fucking vertical)=
14 Kyle: [they're all (good)
15 (p.)
16 Dre: =I think that first one's dropped
17 (p.)
18 Kyle: some of these down here
19 look like they're going the other way though
20 Dre: uh::m
21 (p.)
22 Dre: let's pi::n::
23 (p.)
24 Dre: i'll make a new locality
25 take a bunch of strikes and dips

Excerpt 5b: Situating features within time and place

27 Dre: I: just go::t one ess two::,
28 (2.0)
29 Kyle: phyl::i:::te.
30 (1.7)
31 Dre: >Dude< these almost look
32 (1.0)
33 Dre: °(() they're like):°
34 Kyle: I kn0:w.=look down there.=
35 Kyle: =I see one [that's going this way-
36 Dre: [I kno:w_ you can ^se:e this cu::rve.
37 (1.0)
38 Kyle: We should >wal::k this_<
39 and take some strike n' dips,

Excerpt 5c: Situating features within time and place

In constructing actions and placing them vis-a-vis other actions in an ongoing sequence, participants routinely display sensitivity to the "fittedness" of their contribution with the current course of talk: As a speaker cannot always control for any topic changes in the interaction, if he or she is unable to "get a word in" at one point and that topic ends and another begins, he or she may lose that opportunity to do so without doing so in an "unnatural" forced manner.

For participants working in the field, the mutual orientation towards their task and its

tentative embodiment in co-present features in the landscape both provide resources for formulating and reformulating talk at numerous points in time. We can see this in Kyle's utterance first in lines 18 and 19 and later in lines 34 and 35.

Both are formulations of what are essentially the same features in the landscape but produced at different points in the interaction. The first is produced in concert with Dre and Tyler's talk (lines 5-17). There, Dre was looking at the rocks at their feet and deliberating on the primary orientation of the foliations (i.e., most vertical, line 13). Kyle, looking down the length of the layer, follows Dre's description with a formulation of the orientations he can see in lines 18 and 19, "some of these down here look like they're going the other way though," while pointing toward the layering. We see the same set of features reappear when Dre now makes those relevant in lines 31-33. As articulates the change in orientation as he currently sees it, he gesturally depicts a rolling motion with arm showing the direction of the changes in orientation. Kyle's response displays his having already seen that change even noting direction of a particular outcrop: "I see one that's going this way."

The feature made relevant via Kyle's initial action in lines 18-19 is specifically relevant in the participants' work, independent of his noting it there. We can see that in how he expands on its subsequent reappearance in lines 31-39: "We should walk this and take some strikes and dips." Kyle calling out its presence in lines 18-19, however, has no observable impact on what the participants currently are doing nor does it receive any receipt.

It is not possible to state that Kyle would have reasserted his observation if Dre had not done so, but we see the relevance of features to be formulated and oriented to numerous times in the participants' conduct, suggesting that both it and its placement in the activity are projectable as both point in space and point in their progress along the trajectory of their common projects. The significance or notability of the features exists somewhat independent

of its articulation in each instance. As we see here and elsewhere, however, those articulations and especially their relation to one another do cumulatively formulate their presence and relevance for participants in coordinating their conduct and accomplishing their collaborative work.

Participants do track these formulations--especially when followed by similar formulations on the same object that do not recognize the earlier utterance. A part of what is accomplished here is that two individuals can look to roughly the same object and notice similar aspects about it in ways that are relatively specialized, especially in comparison to how any non-geologist might observe or describe the same landscape.

When a speaker makes relevant the notable absence of a feature in the setting, he or she is routinely heard as finding fault with the participants' ongoing work, specifically how the absence complicates the success of their work. This can be seen in next excerpt, where undergraduate researchers working with Dave, one of their instructors and lead geologists, are collecting samples from a outcrop, when Melinda, peering closely into the rock she is holding, declares "I'm not seeing a lot of hornblende in that" (line 1).

01 ==> Mel: i'm not seeing a lot of hornblende in that
02 Tom: i don't see a lo::t,
03 Tom: maybe fifty five or sixty five percent
04 Matt: there's not a ton,
05 there's some
06 (p)
07 Tom: i'm pretty sure tha-
08 i haven't looked at this rock
09 Tom: but just like twenty feet that way I saw it
10 ==> Mel: not seeing a lot of hornblende though
11 Dave: I agree (-) yeah
12 Dave: so:::
13 people that have been calling out a hornblende
14 Dave: i'd like to see
15 (p)
16 Matt: you'd like to see it
17 Darrell: yeah
18 (p)
19 Dave: at least as i've seen it
20 Dave: they're mostly biotite
21 (p)
22 Dave: careful about looking at biotite on edge
23 (p)
24 Tom: yeah
25 Matt: this one doesn't matter

Excerpt 6: Making absent features relevant

This example shows a number of recurrent aspects of making such observations in the field: 1) Participants resist the negative observation by equivocating on its significance--namely, whether it requires a course change in collective action (lines 2-9). 2) The complaint launched appears less to hold recipient(s) accountable for their conduct, seek apology or remediation, than it does to emend the course of collective action, and in doing so occasion co-participants' responses as to whether they stop, alter, or continue what they are currently doing. 3) And finally, in pursuing this end via talk and embodied interaction, the practice occasions an opening on that concern as the given spate of talk.

Both Tom and Matt respond to Melinda's turn but equivocate on its significance: Tom's response mirrors Melinda's turn, in its perspectival basis, evidential grounds, and at least initial relative amounts of hornblende: "I don't see a lot." He subsequently adds a more specific amount in his next turn: "maybe fifty five or sixty five percent." Matt's subsequent turn dispenses with the evidential grounding and formulates it in completely stative terms: "there's not a ton, there's some." While both responses appear to align with the substance of Melinda's assertion ('there isn't a lot of hornblende, but there's some'), they do so only superficially, effectively equivocating on the notability or significance of her assertion, and operationally as a way of not considering a course change in their collective conduct.¹⁷

It is this interactional dis-alignment that Melinda orients to, rather than its more superficial semantic alignment, where in line 10 she reasserts her observation again, "not seeing a lot of hornblende though," now adding a contrastive *and*, as way of responding to the

¹⁷ Some though not all of the samples being collected at this outcrop require a sufficient amount of hornblende. Not having that severely limits if not negate entirely the information that can be gathered from those samples. Put otherwise, if there is not enough hornblende, they should stop what they are doing.

counter assertions, possibly dismissive "though."

Melinda's negative observation here, though similar to a complaint, works less as an action against any particular recipient's conduct, that is, either in just finding fault or seeking remediation on a prior action, than it is about occasioning a more collective consideration of the group's current course of action and whether the lack of hornblende should prompt a course change in their ongoing and subsequent actions. We can see this orientation reflected in the subsequent response from Dave, one of the two senior geologists in line 11. Here, Dave's pronouncement, though addressing the whole of the group (lines 12-14 and 19-22) can nevertheless be seen as building directly from and thus supporting Melanie's observation: "I agree. Yeah...so people that have been calling out a hornblende, I'd like to see. At least as i've seen it, they're mostly biotite." His response both formulates an experience that aligns with Melanie's contention and offers some remedial way of averting bad samples.

The activities, their settings, intended products, and associated values provided by these frameworks make possible not only the inferences participants can make of others' actions but also the assessments participants can make of those others' competence (Goodwin, 1997, p. 125). And for the participants whether senior or novice, "...the ability to translate such instructions into workable products frequently builds on an ensemble of embodied competence and tacit knowledge acquired by newcomers to a profession in the labs and field settings where the work of their discipline is done" (Goodwin, 1997, p. 117). As such the notability of actions and their coordination results from the "locally relevant, endogenously organized activities" (ibid, p. 131) as well as their projected outcomes. In the case of field geology, rock exposures, stratigraphy, folds, and differences in mineral composition constitute some of these 'locally-relevant, endogenous features' that participants draw on in deploying, interpreting, and coordinating activity, and thus provide for the participants' ability

to engage with their environment and interact within it as a consequential space.

When participants make relevant the absence of otherwise anticipated objects via talk or other embodied action, they often do so to register potential problems in an ongoing course of action. This can be seen in the excerpt below. Just prior to the target utterance Darrell had asked Terry to attempt to identify the origin of an obviously geologically younger intrusion in the the much older rock they are investigating. Just as the transcript starts, Terry inspects via hand-lens a sample given to him by Matt, as Darrell describes it not looking like the rocks Darrell has seen previously. In line 4 Terry quickly agrees also adding that it has Olivine in it, something that Darrell shows surprise towards. The outcome of this sequence and relevance for the subsequent talk is that Darrell had not seen a notable mineral, olivine, prior to Terry seeing it, even though he only saw the sample after Darrell.

01 Darrell: i mean it doesn't look like
02 many of the other mafic dykes we have,
03 in the Beartooths, anyway.
04 Terry: no and it's got olivine in it
05 Darrell: oh it's got olivine in it
06 Terry: m:yeah
07 Darrell: yeah
08 Darrell: i don't recall any of the beartooth ones having olivine

During lapse in talk, Terry drops rock sample and
Darrell picks it up

09 Terry: the lid'l green (p) crystals in there
10 (p)
11 Terry: they look like quartz crystals=
12 =only green
13 Darrell: that's not a fresh surface
14 Terry: told me it was fresh
15 Darrell: it's not very fresh but
16 Terry: na:h::
17 Darrell: oh yeah there are some
18 Matt: yea:h::
19 (p)
20 Darrell: mm mh

Excerpt 7: Negated features and projected courses of action

After Terry drops the sample at his feet, Darrell moves towards Terry leaning down to pick up the sample. Terry treats Darrell as doing so to look for the olivine and points to the

rock while describing their appearance: "the little green (p) crystals in there. They look like quartz crystals, only green." After briefly looking at a location on the sample through his hand-lens, he declares "That's not a fresh surface," as he abruptly moves the sample away, rotating it in his hand, presumably looking for where he might see the olivine.

While the negation is responded to as formulating a complainable: we see Terry defer blame to someone else; Darrell responds by downgrading his prior assertion, "it's not very fresh but." The extent it is pursued by Darrell, however, effectively ends with his successfully seeing olivine: "oh yeah, there are some." The notability of the sample not being fresh is more explicitly understood procedurally where participants operate on how the now relevant feature (or its absence) intersects with their current course of action and whether that requires some modification on the co-participants' part.

The feature, aspect, or quality negated in a negative observation has alternative formulations. In the excerpt below, Dave arrives at where Darrell had just been having a discussion about the origin and age of an intrusion, and why the group would not want to sample the rock (precisely as Dave asserts in line 8: It looks "pretty fresh, that is, too young to be the much older rocks they are investigating (pre-cambrian), and thus, "not pre-cambrian." Dave, however, was not present at this earlier discussion, and so appears more motivated in averting the possibility of Darrell incorrectly sampling this rock.

03 Dave: uh:::m
04 (p)
05 Dave: looks pretty fresh to me darrell
06 Darrell: that's very fresh
07 (p)
08 Dave: as in::: (.) not pre-cambrian
09 (p)
10 Darrell: exactly

Excerpt 8: Negated features and projected courses of action

The way in which Dave formulates and reformulates how a given feature (or aspect of it) appears to him, displays an interactional concern for both not needlessly collecting samples from the incorrect rock, while not also presuming that Darrell did not already know that or that Dave is taking it upon himself to enunciate that. This conflict can be inferred from Dave's mitigating "uh::m" in line 3, the delay in line 2, as well the way he evidentializes his utterance in line 3: "looks pretty fresh to me." While he incrementally reformulates that with negation in line 8: "as in not precambrian," he nevertheless avoids explicating how this formulation is actionable (i.e., do not sample this rock).

Aside from the use of negation in this excerpt, we can see the rock being "fresh" and "not pre-cambrian" are formulations of the circumscribed domain of their work in the co-present landscape and how its falling outside of that work. Negating features does not actually have to be about the lack of some thing or quality, but rather about the presence of something otherwise excluded from their actual objects of interest. The point of stating this is not simply that there exists alternative ways of formulating a given thing in the setting, but that these formulations exist in relation to one another. As such, for the objects that interactants formulate in their talk, "to be" or "not to be" is ostensibly not the only question.

"I'm not seeing much hornblende in that" is negative observation. It formulates an absence as the notable event and treats that as problematic for their ongoing activity. While its negative construction is integral here in formulating the absence of hornblende, and doing so is a common way for speakers to formulate situations that are problematic and in need of remediation, the impact that the negative observation has on the activity is given in the relation between the presence or absence of hornblende and the activity itself. Making relevant the absence of some object(s) does not in itself set up a problem that needs to be fixed in the moment. We can see this in Kyle's talk in line 6 below.

01 Dre: if there's any good fuckin' faces
02 (2.1)
03 Tyler: this['s straight
04 Kyle: [there're a couple?
05 (1.3)
06 Kyle: I don't see any ess two: for su::re.
07 Dre: Noo::.
08 (0.7)
09 Dre: I[:: haven't seen much of ess]two::_
10 Tyler: [TWO THIRTY TWO SIXTY S:ix.]
11 (0.6)
12 Dre: in any of 'em.
13 except fo::r, when we were in that di::tch.
14 Tyler: ESS ONE
15 =two thirty [two °sixty° s-
16 Dre: [o:h here's an ess two::
17 =right he::re,
18 (0.9)
19 Kyle: Two thirty two sixty si:x
20 °two thirty° two sixty si:x.
21 (3.5)
22 Kyle: for ess o:ne?
23 (.)
24 Tyler: Yeah.
25 (0.8)
26 Kyle: day two:: stop two::_
27 Dre: I: just go::t one ess two::,

Excerpt 9: Negated features and projected courses of action

Here, the absence of the formulated object does not lead to either Kyle or his co-participants stopping what they are doing. The absence of s2 foliations treated as notable, somewhat actionable, but not an obstacle to their current conduct. Dre's subsequent discovery of s2 foliations, while unexpected given he and Kyle's admission of not seeing any, is given little notice by either Kyle or Dre. There are differences in the composition of each formulation: Kyle's utterance is in simple present tense "I don't see any s2," while Melanie's "I'm not seeing much hornblende in that" uses continuous tense. There are also differences in their relative placement via the speakers' and others' talk. Melanie's utterance is produced more "out of the blue" without substantive relation any prior talk. Kyle's utterance is built to an extent from the local talk: After Dre's complaint regarding the lack of good faces for measuring the dip of the foliations (line 4), Kyle responds "there's a couple." His subsequent negative noticing about the lack of s2 formulates one type of foliation, s2, as opposed to s1 foliations, which are the unnamed foliations that they had previously been referring to:

"there's a couple [of s1]." We can see after Tyler reports his measurements (lines 10 & 15), Kyle clarifies which type of foliation Tyler is reporting on in line 22: "for s1?"

Discussion

The manner in which features become notable to field geologists is argued to be a consequence of the significance that they play in their ongoing, situated work, and the degree to which these are observably recognized as such by the interactants. Accordingly, I argue that the utterances that perform noticing in these settings become actionable less with regard to the stream of speech than they do with regard to the stream of their projectable tasks and activities. Below, I draw on a number of concepts of the constitution of activities for elaborating on this point.

The practices analyzed in this chapter that are used for making relevant features in the co-present setting are argued to function in their formulating not only the feature, but also its relevance to an ongoing activity--whether that be advancing the activity, suspending it, etc. As such, the practice, whether we call it noticing, accomplishes this by also making relevant particular "heres" and "nows"--as points along a particular course of work.

We see this in the instances analyzed above. Where disputes arises over a formulated feature, participants can differ on the significance of the formulation, as we see in Excerpt ##, for instance, Melinda, Tom, and Matt disagree over the relative amounts of hornblende). Conversely, participants can differ not on the import of the feature, but whether it has any significance for the activity as it is currently understood. We see this in Excerpt ##, where Darrell declines recognizing the significance of Matt's finding because of the heterogeneity Darrell formulates as being given in the current rock outcrop. When Matt reasserts the significance of the feature via reformulation, he does not change its significance (it is still notable for being "really different"); rather, his reformulation maintains the feature's significance in light of Darrell's prior response. The formulated feature is thus analyzed against what is taken to be operant in the given activity, which itself is modulated by the

current setting (i.e., a place with a lot of heterogeneity).

Noticings operate in their exhibiting and being accountable for some aspect of the given activity or setting. Moreover, we can argue that they in part formulate what is taken to be relevant to the setting within the activity. Sacks recognized a paradox in members' formulations, namely that "[m]embers can't do pure formulating...[that is, they] can't be engaged in 'merely'- non-consequentially, non-methodically, non-alternatively--formulating [what] they are doing as they are doing it" (Sacks, 1995, p. 516): e.g., giving an explanation is not equivocal to explicitly saying that one is doing explanation; similarly, acting within a particular occasion or setting is not equivocal to explicitly saying that one acts within the occasion or setting.

Nevertheless, interactants and their actions are routinely treated as operating within a given spate of activity and, moreover, derive much of their sensibility and actionable import for doing so. An issue that this observation gives rise to is the exact resources that participants use for interpreting how particular actions are "setting'd" (ibid, p. 516). One set of turn-constructive practices that Sacks nominated as useful in this respect are "indicator terms"--otherwise known as deictics or indexical terms, that is, lexemes like "this," "that," "here," "there," "now," or "it," among others (ibid, p. 517). He argued these to be useful for their "omnirelevance" which provides interactants a means to invoke "...the sheer fact of the setting without the specification of the setting." (ibid, 518).

Indexical expressions, however, operate within a certain ambiguity with regards to their occasioned use: while they may tacitly invoke settings, they may not actually specify the feature that makes that setting relevant. While "this" instructs an interactant "to look for some object" (ibid, p. 515), that object may exist on numerous layers of meaning. Paraphrasing Wittgenstein Sacks asks, "If I point to something and say 'this,' how are you supposed to

decide that I'm talking about the nameable object, its color, this side of it, its depth, whatever else?" As such "...the very order of phenomenon being invoked by the indicator, is [itself] not invoked by the indicator" (ibid, p. 518). While this ambiguity presents an inferential problem, Sacks speculates that their "abstractness" allows "here and now" to be formulated for any particular here and now (ibid, p. 520), and as such, "...invoking unformulated settings, referring to uncategorically identified persons, and noticing uncategorized activities, could be [part of the] machinery for allowing this work (ibid, p. 520).

In the geologists' work, indexical expressions appear may similarly operate as resources precisely for their inferential ambiguity. Without their co-formulating a given activity and setting, they are indeed underspecified and present an immediate problem for an interlocutors that cannot be solved with regard to the talk alone. Their use may act as a means for observably showing that a speaker is invoking a setting via use of an indexical expression. This in turn deictically embeds the utterance in that setting such that it becomes meaningful only with reference to that invoked setting. Moreover, while the use of these indexical expressions may provide a practical means for formulating setting whether that be time, place, or thing, and thus provide for some of the projectable and anticipatory work that the geologists produce, more importantly they "...make a setting out of some course of activities" (ibid, p. 522). From this actors develop time as a feature of activities, space, histories, etc.

For the analysis pursued here--and indeed for the particular analytical values that this study takes to be paramount to the study of the situated, collaborative work that humans engage day in and day out, the means by which participants collaboratively operate within given activities, places, and histories as longitudinal features of daily life are inseparable from their constitution in social interaction.

For the geologists analyzed here, the tasks, activities, and projects that they pursue with others is likewise inseparable from their movement within the landscape: The path that the participants take through a given landscape is synonymous with the collaborative work that they undertake. Ingold reminds us here that "...[i]t is from this relational context of people's engagement with the world...that each place draws its unique significance" (Ingold, 1993, p. 156). The meanings--that is, the descriptions, measurements, and images the geologists "gather" in particular places are in sensible to the degree that "each place embodies the whole at a particular nexus within it, and in this respect is different from every other" (ibid).

Much like the path that the geologists may take over the course of their day's work, the work that geologists perform in that landscape, including the movements they make, the points where they stop, the notes, samples, and measurements they take, and all the manner of perturbations, hesitations, and backtracks that they perform in this work are all tracked for their relation to one another and, moreover, assessed for their signifying the completion of their collaborative work: "Every task takes its meaning from its position within an ensemble of tasks, performed in series or in parallel, and usually by many people working together" (Ingold, 1993, p. 159) This "taskscape," as called by Ingold, accounts for how practitioners enact and perceive the temporal progression of their work through their interaction with others. Borrowing from Merleau-Ponty (1962:421), Ingold argues that "the passage of one present to the next is not a thing which I conceive, nor do I see it as an onlooker, I effect it," (Ingold, 1993, p. 160). In turn, it is within the taskscape, that "I perceive, at this moment, a particular vista of past and future...a vista that is available from this moment and no other" (ibid).

In Ingold's discussion of the relation between temporality and the landscape, he attributed to Durkheim the fundamental error of divorcing "the sphere of people's mutual involvement

from that of their everyday practical activity in the world" (Ingold, 1993, p. 161). Indeed, this same fundamental error can be ascribed to our analysis of actions like noticings. While we continue to situate actions within sequences of talk, we may lose sight of practices which are much more concerned with larger trajectories of action than can be found within sequences. The analysis presented here, if it provides an account sensible to situated work of the geologists, does so through its demonstration of how noticings and similar practice effect the collaborative projects being pursued.

Exposing Fault-lines in Explanatory Frameworks: An analysis of endogenous pedagogy in novice and senior practitioner interaction in geological fieldwork

Introduction

The interactions analyzed here consist of participants pursuing collaborative explanation via agreement on assertions that allow further collaboration, including subsequent observations and measurements. The productivity of a given assertion is argued to be operated along two courses of action: those that mobilize participants' agreement, and those that mobilize subsequent explanation. Prior to starting the analysis, I will elaborate what is meant by premise and other ways in which knowns can be understood.

While ways of knowing can be intuitive or unconscious, when actually articulated in interaction, they operate as propositions about the world. Ludwig Wittgenstein was among the first to point out that while many propositions--though they appear empirical in nature--behave more like normative or logical operations. Describing these propositions as non-epistemic, he argues these propositions normally exist outside of doubt and thus "...no longer on the route of enquiry but underlying or governing it" (Hamilton, 2014, Kindle Location 428). If a speaker is certain of these propositions or knows their truth without doubt, Wittgenstein argues that this is "...not because they have been exhaustively confirmed, but because they constitute the framework within which other statements can be questioned or confirmed." They're "...presuppositional and basic in the very process of gathering and assessing evidence or within our more general "world picture" (ibid, Kindle Location 1094). These propositions are described as non-epistemic because they are deployed in interaction without being articulated: "My behavior shows the many things that I know hold certain, without articulating them in words" (ibid, Kindle Location 1612). They provide the backdrop

that makes our overt reasoning sensible and rely on a "...certainty produced by linguistic training" as opposed to enquiry" (ibid, Kindle Location 1705).

It is not the case that knowledge of this sort remains always premised, presuppositional, and unexplicated; furthermore, their assertion does not necessarily lead to specific inferences, nor does it mean they are necessarily assented to by others. This is only the normative expectation for this class of knowledge as a part of our more general "world picture."

Analyses in this paper demonstrate that participants often orient differently to various assertions; often what is given earlier in the talk as framework proposition can be realized later as an actual object of inquiry for some participants, only to be redeployed subsequently as a restored framework proposition. Wittgenstein recognizes early on that this status is not fixed: The "...contrast between what is tested by experience, and the rule that does the testing--and their changeability--is central" (ibid, Kindle Location 923).

The difference in the epistemic status of different propositions and their changeability is echoed in other literature, including the Duhem-Quine thesis and Latour's black boxes. The Duhem-Quine thesis stipulates that scientific arguments are never tested in isolation of one another. As Sismondo explains...Theories are parts of webs of belief. When a prediction is wrong, one of the beliefs no longer fits neatly into the web. To smooth things out - to maintain a consistent structure - one can adjust any number of the web's parts (Sismondo, Kindle Location 337).

The mutable nature of the epistemic status of scientific arguments or artifacts--namely, their ability to transform from non-epistemic suppositions to actual contested objects of knowledge--can also be seen as a function of their situated use in different contexts. Whereas in one context, a proposition is completely suppositional, unquestioned, and functions wholly

as a "hinge" or logical rule, in another, it is its own claim that is being tested. The movement in epistemic status from a proposition being tested to being testable is analogous to what Latour describes as black-boxing. A black box describes an object, system, or configuration whose internal workings are ignored in favor of its input and output. In science, when a fact, finding, or theory, becomes accepted within a community, it is sanitized of any "...fabrication, construction, or ownership" (Latour, 1987, p. 15). It loses any of the controversy in which it developed; "configurations become black boxes, objects that are taken for granted as completed projects, not as messy constellations" (Sismondo, 2011, Kindle Location 2001). This is analogous to a proposition moving from a testable object of knowledge to a premise: it is no longer decomposable or inspected internally, and instead is only questionable in its application. When controversies erupt regarding previously held beliefs or previously accepted scientific facts, findings, and theories, black boxes do get re-opened exposing their internal machinery. Analogously, ways of knowing can be reexamined in contexts where participants are actually testing the empirical validity of the premise.

Latour himself explored the rhetorical embedding of previously given "facts," describing how in discourse they either led away from the conditions of their production (sealing the black box), or lead back to the the conditions of their production (opening the black box). There are additional ways in which to describe the rhetorical transformation of scientific ideas; for instance, in Becvar et al. (2008), a complex gesture undergoes transformation from the object of a fully elaborated argument to a lexical reference used in building further arguments. The present paper is concerned primarily with the rhetorical use of propositions and supposition by participants as an institutionally, specialized form of discursive practice, and argues that its underlying reasoning works towards agreement.

Analysis

The data for the analysis below come from a class assignment from a capstone field course required of undergraduate geology students prior to graduation. The capstone course took place over the course of week in the Madison River Valley, Montana. In this assignment the students have to reconstruct the geomorphology¹⁸ of a particular location. This involves the interaction between a seismic fault and a river running down the length of a ravine traveling down the mountain. The fault has erupted numerous times in the geological past leaving evidence of these events. The river, however, in shifting back and forth during this past, has erased parts of the fault leaving an incomplete record of each event. The presence of two processes are introduced to the students prior to the exercise (see figure 3 from Ruleman, Larsen, & Stickney, 2014, pp. 82-3).¹⁹ The exercise is divided into several activities over two days, and includes a) surveying all the relevant terrains, b) measuring the profiles for the lower and upper scarp (line 1a and 1b), and c) writing a group essay reconstructing the present geological processes and their temporal order.²⁰

¹⁸ Geomorphology, for the purpose of the current paper, is the "...study of the origin and evolution of topographic features at or near Earth's surface via seismic, glacial, fluvial (rivers), pneumatic (wind), and biologic (flora and fauna) processes and their interaction with one another.

¹⁹ Line 1 is the scarp created by a thrust-fault. With this thrust-fault, the "footwall" moves up in relation to the "hanging wall." Line 1 has a lower offset (line 1a) and an upper offset (line 1b; see the vertical differences in the profiles in figure 2). Line 2 is an ancient river-terrace (or 'bank') created by a river that has since moved sixty to eighty meters to the east along the fault on line 1 (thus creating the different offsets). Line 2 also has a lower and upper offset (line 2a and 2b, respectively), which are not measured. This current topography was created by two seismic events, the most recent occurring in 1959 as a 7.3 earthquake, and the penultimate occurring in the past (the lower terrace is dated from 800 to 1400 years b.p., and the upper terrace, 6000 to 11000 years b.p.). The darker rectangle near the B-B' profile is a trench dug in 2000 c.e. The only information that is "given," or already known by the students prior to the assignment is the location and nature of the upper fault-scarp, and the date of its last seismic activity: 1959. The remaining features--though easily noticeable--remain to be determined, as does the relative temporal ordering of their creation and transformation.

²⁰ Since the analyzed group interactions occurred early on, and at different points, in the exercise; the analysis should not be understood as comparative in regards to their respective performance, nor should their exhibited conclusions be treated as anything but provisional. What is being compared in the analysis, however, is the different discursive practices and practical reasoning displayed by the participants at those points.

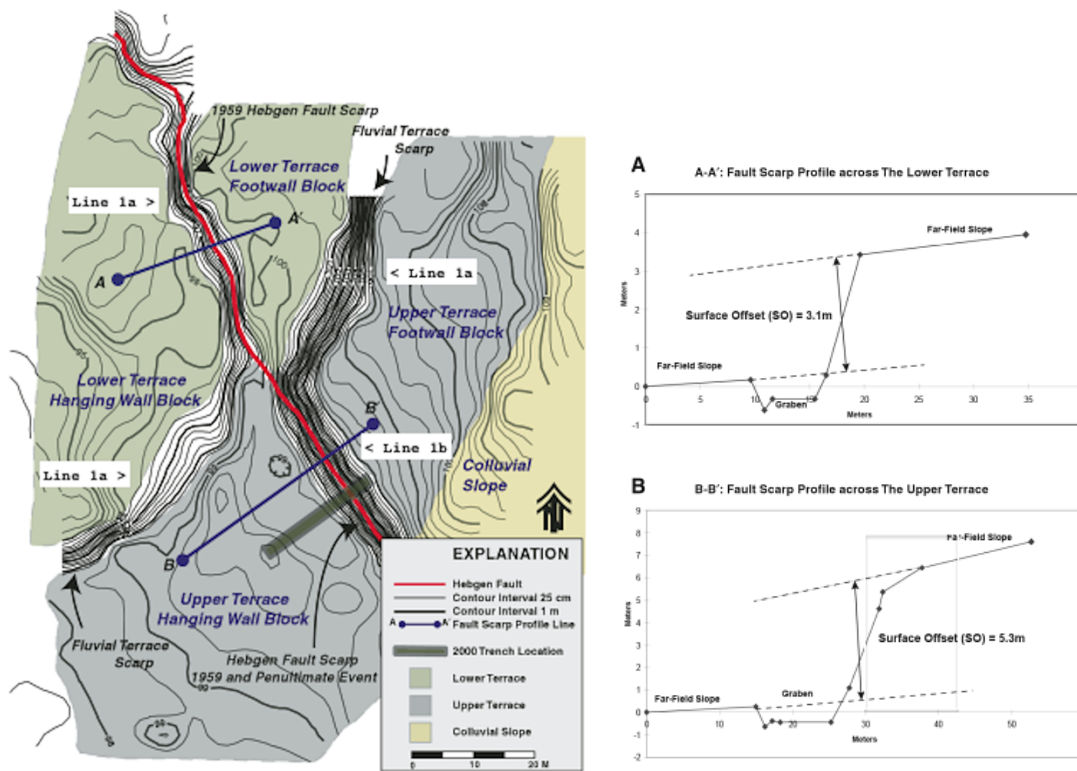


Figure 3: Topographic map and profiles for upper and lower scarp

The first group analyzed here is Kate and Anna. The interaction begins on the morning of the first day, prior to the first lecture and measuring the profiles of the scarp. At this point, the students have only been asked to conduct a site survey.

The upper offset of the scarp on line 1b has already been identified as a fault-scarp, that is, the large offset caused by the Hebgen fault. As such it being a "known" provides relatively firm ground on which to build a description. Notice, for instance, in the following excerpts that while the participants add subsequent fault descriptions/claims about the location, e.g., there being a "river terrace", a "flat area" (i.e., floodplain), and that the fault-scarp blends in with the hill (ex. 5, lines 3, 5, 9, 10, 20, and 22), they continuously return to "the fault scarp" as a stable given in their discussions (ex. 5, lines 2, 8, & 18; ex. 6, lines 34-5, 7, 38-9).

(1) jc_14-06-22_hebgen_A_ka-A

01 DAVE: what'chya seeing in here
02 ANNA: well, there's th'fault scarp.
03 and then there's the other river terrace
04 DAVE: okay, where's that.
05 ANNA: the river terrace,:: is [like (1.2)=
06 KATE: [this one (going along)
07 ANNA: goes down,
08 ANNA: cause that's the fault scarp
09 and then you have this like flat area
10 ANNA: and then that other drop off is the river terrace
11 DAVE: mhm
12 MICK: just the river terrace.
13 ANNA: I think so
14 DAVE: are- are there more structures up there?
15 ANNA: I don't know (yu-whu/yu'wun-)
16 (KA): ()
17 ANNA: I think the river has changed a lot of this area
18 because like the fault scarp is=
19 =really pronounced right there
20 but then it just kind of
21 (0.8)
22 ANNA: bl[ends in with the hill up here
23 KATE: [(it goes off)
24 KATE: ()
25 ANNA: so we're gonna (.) keep lookin::,
26 DAVE: okay
27 KATE: cause it like ((schl)umps off here)
28 ANNA: yeah

Excerpt 1: Continual return to exposed fault-scarp as stable known

When the senior geologist, the instructor, Dave, asks "what'chya seeing in here," Anna begins her response, "well, the fault scarp" as she points to the location where the scarp is at its most exposed and obvious in appearance. When the instructor pursues the prior response with "where's that?" (i.e., the river terrace), Anna locates it initially with reference to the river, away from the prominent scarp, and traces its path along line 1a towards the scarp (lines 5 and 7.²¹) At line 8 though, she reformulates her account, now specifically locating of the river terrace with reference to the fault-scarp as she gesturally traces each part (lines 8 though 10): "cause that's the fault scarp and then you have this like flat area and then that

²¹ Estimations of the location of the interactions are marked on the topographic map according to their excerpt number.

other drop off is the river terrace." Even when asked if there are more structures up the river, Anna responds with a disavowal (15: "I don't know") and qualifies that the "river has changed a lot of the area," and then accounts for this assessment by returning--again discursively, rhetorically, and deictically--with a point to the most pronounced part of the scarp in lines 18-22. Her partner Kate agrees with this assessment stating "it [the scarp/hill] like schlumps off."²² The participants will return to this 'bit' of knowledge--the location of the pronounced fault scarp--again in their reconstruction of the location's geomorphology in ex. 3, lines 43-4.

Reconstructing the geomorphology of the site--via the integration of given, inferable, and/or discoverable (i.e., known and soon to be known) geological features--into a temporally ordered account is precisely the task to be accomplished in this field exercise.²³

(2) jc_14-06-22_hebgen_A_ka-C

29 **KATE:** okay, so where was the- um::: (0.8)
 30 **ANNA:** okay so all this sediment,
 31 that was brought down into here, was all eroded
 32 when that fault scarp lifted up, and so it completely
 33 changed the course of the river through here,
 34 and there--the fault scarp used to come around through
 35 here::, and [now I think its::
 36 **KATE:** [oh, so it was wrapped around?
 37 **ANNA:** well,=no.=it came like this way:::
 38 [and the river:::
 39 **KATE:** [(oh:: it came through right here)
 40 **ANNA:** yeah and the river had to go over the fault scarp
 41 so it- it like created a waterfall
 42 and then,
 43 **KATE:** [()
 44 **ANNA:** [it like eroded it all the way:::

Excerpt 2: Narrative reconstruction of fault-river interaction

²² This entire sequence is significant for a number of reasons. It should be noted that the instructor asks for the location of the river terrace and not the scarp, because while the prominent scarp is a given at this point, 'the river terrace' is treated as the most speculative part of Anna's response, and thus requiring justification. Her subsequent response is problematic, because what she points out is not a river terrace; it's a continuation of the fault.

²³ A temporally ordered account is essentially "a story," though not any story can serve this purpose. This distinction is best demonstrated in excerpt XX, where the story given is designedly more "counterfactual" than it is "factual".

Anna's response to Kate's question in excerpt 2 is produced as narrative (lines 30-5, 37-8, and 40-4). In it she describes how all the sediment deposited by the river was eroded by the fault-scarp, changing the course of the river, before eventually being eroded away by the river. Her story is only intermittently anchored in the current context though (this is observable as well in ex. 4 and 4a). In lines 30 to 32, only the deixis "here" refers to the current speaking context; the rest, "this sediment", "that fault-scarp", "this way", and such, refer to non-present phenomena, everything that was "eroded away." As such, the story is more typological than descriptive: it describes how any river interacts with an active thrust-fault scarp. It is difficult to determine then how responsive Anna's story is to Kate's prior request. If Anna heard Kate to be asking about the fault, Anna's response goes to show why it is not locatable.

Kate's course of action (ex. 2, lines 36, 39; ex. 3, lines 21-2, 28-9, 31, and 35) acts in a) questioning the status of other geological features (besides the scarp), and b) ensuring consistency between current and prior informings in the interaction.²⁴ This can be seen as early as her questions in lines 36 and 39, where she responds with surprise (given the "oh" change of state marker (Heritage, 1984), even though Anna stated previously numerous times that the fault ran through this exact location.²⁵

²⁴ The participants' use of "fault scarp" has so far been underspecified in this text--and as I argue--in the participants' talk. A "scarp," strictly speaking, describes a geological form consisting a vertical exposure that connects a lower and upper elevation--without implying any causation. As such, any cliff, hill, river terrace could be described as a scarp. In using "fault scarp," however, a speaker is heard to mean a scarp caused by a seismic fault. Importantly this means that while a scarp line may move across the surface--as is the case with the shifting bank of a river terrace for example--a fault scarp, however, may not. As such, while the scarp--the vertical displacement--caused by the thrust-fault might have been eroded by the river, the fault that created it could not have moved at all. As such, the statement, "the fault scarp used to come around through here" is either misspoken or rests on a problematic premise.

The purpose of this excursion on the nature of scarps and previous assertions made is that when Kate asks her questions, they're significant because they're oriented to as displaying doubt on the so far building story.

²⁵ This persistent questioning can be seen as a manifestation of what Sperber et al. (2010) call epistemic vigilance, where the participants continuously monitor updating states of knowledge for consistency and/or discrepancy.

(3) jc_14-06-22_hebgen_A_ka-D

17 ANNA: but this is uh:: extremely dynamic area right here
18 KATE: yeah
19 ANNA: so it's moving like a ton of stuff out
20 ANNA: I think if I [remember correctly
21 KATE: [is that why::like see it's like-
22 (that's the) [(.) continuation of the fault scarp=
23 ANNA: [yeah,
24 KATE: =[right there
25 ANNA: [an' it-
26 KATE: yeah, because if it went across the river right here=
27 ANNA: =[yeah
28 KATE: [so does that mean this is the fault scarp right now,
29 KATE: and not a fluvial terrace
30 ANNA: no cuz I think the river used to go like this
31 KATE: I know but we were over there and you were calling=
32 KATE: =this [] [(a:) fluvial terrace::=
33 ANNA: [yeah, this] [is a fluvial
34 ANNA: =yeah.
35 KATE: so::: are you (r-) bottling that,
36 ANNA: I don't know:::,=
37 KATE: hi(h)-[hi(h)hi(h)-hi(h)
38 ANNA: [it's weird:::
39 ANNA: [there's a lot of stuff=
40 KATE: [()-
41 ANNA: =going o:[n here
42 KATE: [i've never been up here ()=
43 ANNA: =I mean I definitely know that,
44 that big one up there is a fault
42 but I think the interaction
43 between the fault and the stream is really complicated
44 KATE: (yeah ())

Excerpt 3: Questioning reconstruction

In lines 21-2, building off Anna's prior utterances about the fault-scarp having 'used' to run through the location, Kate asks, "is that...the continuation of the fault scarp?" pointing across the river. She then connects that in line 28-9 to what has so far been presumed/determined to be a "river terrace," asking "so does that mean this is the fault scarp right now, and not the fluvial terrace?" Anna discounts this inference, "no cuz I think the river used to go like this," tracing gesturally the proposed historical path of the river so that it abuts the river-terrace/fault-scarp. Kate displays herself as more concerned with identifying discrepancies in what was previously said (lines 31-5): "I know but we were over there and you were calling

this...a fluvial terrace...Are you bottling that?" In response, Anna relinquishes certainty due to there being "...a lot of stuff going on here." It is interesting that immediately after this display of uncertainty, Anna again returns to one certainty, pointing back to the pronounced fault-scarp (line 1b): "I mean, I definitely know that, that big one up there is a fault." Kate's questioning functions as a display of doubt by identifying geological features in a manner that are not adequately accounted for by the current narrative.

(4) jc_14-06-22_hebgen_A_ka-E

01 ANNA: Well, maybe like the river branched into two sections,
02 and it eroded all of this over here,
03 and then it eroded all of that over there
04 KATE: Eroded what? the fault?
05 ANNA: No, like- the fault- ...Okay, so like- (1.0)
06 the fault lifted up...and the river had to come off that...
07 KATE: =Yeah. I get that.
08 so I think that...
09 ANNA: ...the fault...went like this, brought that down
10 ...or this went up; it changed the base level of the creek,
11 so it had to erode more, and so all of this got all eroded
12 and created this terrace.
13 KATE: That makes more sense than what we were thinking before.
14 So the other one was still the fault scarp
15 and this is still fluvial terrace.

Excerpt 4: Recognizing weaknesses in reconstruction

Later in ex. 4 and 4a, Anna describes the river as having carved out the lower terrace where the participants were standing (lines 1-3). When asked to clarify what "eroded" (4), Anna again describes how a scarp is created. Even Kate orients to this as already given, obvious, and possibly not needed in saying (line 7: "Yeah, I get that"). Kate's previous display of doubt can even be seen to operate in her eventual agreement (ex. 4a, lines 17-20). In it, she states that both the fault-scarp and the fluvial terrace are "still" what they were previously described as, thus discounting the prior discrepant account (at least for now).

(4a) jc_14-06-22_hebgen_A_ka-H

16 MICK: What were you guys considering before?
17 KATE: Well, we kind of changed- I thought for a second
18 that this was the fault scarp ((pointing to the terrace))
19 ...because it looked like it continued this way.
20 ((pointing to the fault-scarp across the river))
21 ANNA: But I don't think it really does
22 KATE: Now with what she's saying about the change in
23 ...base level, the river incised, and the
24 fault-scarp stayed where it was.

Excerpt 4a: Integrating accounts

Later in the day after the lecture, Anna and Kate join two other participants, Mackenzie and Emma, and start measure the scarp profiles. The interaction below takes place after the group measured line 1b but before they have measured line 1a. Relevant to the analysis is a) Kate's questioning (lines 8, 11-6, and 21-2), b) the reasoning that Mackenzie displays (lines 32, 34-6) for her response and retort that the lower scarp is part of the same fault as the upper scarp (line 24 and 43), and c) Anna's responses (37-8, 41, 44-7).

(5) jc_14-06-22_hebgen_A_meka-D

07 MACK: like=
08 KATE: is this still the fault=oh yeah it is
11 KATE: OH MY GOD
12 (what they're saying)
13 this is ()
14 this is the fault scarp
15 because it comes around this way=
16 =we're [(were thinking it goes)] that way (.)]
17 ANNA: [(oh:::::)]
21 KATE: [doesn't it,
22 does it?
23 ANNA: ^oh:::: [()]
24 MACK: [this is the same (.) fault
25 KATE: [I know] [(.)] but uh- uh- we were thinking=
26 MACK: [(as-)] [as this]
27 KATE: =that behind us was [the fault scarp]=
29 KATE: =[this en]tire time
32 MACK: oh::: I don't think so
33 KATE: like behind us cause see how it goes like that
34 MACK: it does do that but it wouldn't make sense
35 for the- a fault just to run
36 and then turn [ninety degrees
37 ANNA: [well,=
38 =let's look at the [topography though guys
39 MACK: [like that
40 KATE: [ow
41 ANNA: [it comes around
42 ANNA: Katelyn=
43 MACK: =this is the same fault
44 ANNA: it would be misleading to think
45 that this continues on like that
46 but it doesn't.=it curves around back this way
47 that and then this is that
48 KATE: but we're [all measuring this
49 ANNA: [(you know)
50 ANNA: yeah, but we have-
51 cause we're measuring a fluvial terrace too
52 KATE: oh we are

Excerpt 5: Challenging reconstruction via normic statements

In line 8 Kate displays the re-realization that the lower scarp--what was previously called the river terrace--is in fact part of the same fault-scarp. Even Anna seems amenable to this change, as suggested by her change of state markers, "oh", in lines 17 and 23. In response, Mackenzie affirms Kate's question and asserts "this is the same fault scarp." After Kate describes her and Anna's prior thinking, Mackenzie responds, "it does do that [i.e., "goes like that"] but it wouldn't make sense for the- a fault just to run and then turn ninety degrees."

Here, Anna reverts to suggesting that the scarp indeed bends at the place they are currently standing, grounding the claim on the "topography": "it would be misleading to think that this continues on [i.e., goes straight]...but it doesn't; it curves around back this way."

Many of the utterances deployed in the interaction were done so for the purpose of supporting the initial premise--that the adjacent scarp, line 1a, was created by the river and not the fault. Additionally, their deployment occurred most often in response to displays of uncertainty, or in the face of discrepancies. This seemed to persist until the alternative account was eventually discounted. As such, agreement appeared--in line with this paper's argument--to be an operating principle for the participants' use of knowns, prior to any consideration of the validity of their subsequent explanations (even if that eventuality was certainly oriented to for the assignment). There were considerable problems in the participants' developing account, though none had yet explicitly posed that as a problem until the last analyzed interaction in excerpt 5. Through displaying doubt, however, the participants could pose problems without doing overt disagreement, and so could work primarily on testing the grounds for their agreement.

The use of knowns or presuppositions begins similarly in the next group; they are deployed in pursuit of agreement as much as in pursuit of determining their own accuracy or validity. These interactions, however, differ first in having benefit of coming later in the day after the initial lecture, coming after the group measured the upper and lower scarp (line 1a and 1b, respectively), and most importantly having an instructor's input.

In this interaction (ex. 6), Tyler, Drew, and Kyle, are looking at the topographic map for the site, as they try to locate their position with regard to geological features, including the "river" (6), "floodplain" (7), falls, etc., and provide a potential narrative for what occurred

there (lines 9-10): "initially=it was going out here=built up, then got shifted down into here".

(6) jc_14-06-22_hebgen_B_tdk-A

06 DREW: [so this river could've::
07 DREW: you know this (whole) flood plain=
08 =[over here
09 TYLR: [initially it was going out here=built up,
10 then got shifted down into here
11 KYLE: and started down cutting [(the falls)
12 TYLR: [down cutting
13 TYLR: [down cuttin-
14 DREW: [yeah
15 TYLR: depo- it deposited
16 TYLR: what we're standing on now
17 DREW: [mm mh
18 KYLE: [yes.
19 And it cut into that hill
20 DREW: [()
21 TYLR: [(it) deposited what we're standing on now
22 TYLR: and then was already doing this action
23 TYLR: when::: (.) well (.) I don't know [whats ()
24 KYLE: [well it was just
25 KYLE: flowing over here
26 DREW: [yeah yeah
27 KYLE: [where [the waterfall
28 DREW: [I mean this was all just (planed)
29 TYLR: and then
30 KYLE: and then the fault [happened=
31 TYLR: [multi-
32 TYLR: =I mean the fault-
33 (.)
34 TYLR: but this is a multiple event because::
35 (.)
36 TYLR: I think it's single
37 DREW: [I think it's single
38 TYLR: [I don't- I don't think so

Excerpt 6: Building account of interaction

Disagreement appears early on in the talk (lines 30 through 38) and on fairly specific grounds: whether or not the geomorphology was the result of a single event (Kyle and Drew) or multiple events (Tyler).

(7) jc_14-06-22_hebgen_B_tdk-A

30 KYLE: and then the fault [happened=
31 TYLR: [multi-
32 TYLR: =I mean the fault-
33 (.)
34 TYLR: but this is a multiple event because::
35 (.)
36 TYLR: I think it's single
37 DREW: [I think it's single
38 TYLR: [I don't- I don't think so
39 DREW: if this- if th- you saying this could be a scarp
40 TYLR: no this no I'm thinking this scarp
41 TYLR: [I don't think ()]
42 KYLE: [you think it ends] right there
43 TYLR: I don't think it displaced that whole distance=
44 =in [nineteen fifty-nine
45 DREW: [(all in one ())]
46 TYLR: [I think] [(I'on't-)]
47 KYLE: [((nod))] [((nod))]
01 TYLR: but think how- how big that was
02 TYLR: remember he was telling us like
03 DREW: [()]
04 TYLR: [three to four meters is like (.)
05 a seven [point two
06 KYLE: [yeah
07 KYLE: but- but then there's story
08 about the camp[fire and the ((fire)
09 DREW: [hey he wants to
10 KYLE: (after)) the table
11 KYLE: [why would they build

Excerpt 7: Incipient disagreement in accounts

Drew begins by problematizing what he displays to be the presupposition for Kyle's argument and asks Tyler if the river terrace (line 2b) is what Tyler is calling one of the events ("you saying this could be scarp?"). Tyler denies this (40) with "no=this..." while initially pointing towards the terrace, and then continues, "no, I'm thinking this scarp," as he turns further towards what he presumes to be the actual scarp (the pronounced scarp at line 1b), and formulates his position in explicit: the height of the pronounced scarp at line 1b is too tall to have been created by one event (43-4).

(8) jc_14-06-22_hebgen_B_tdk-B

11 [so =that story about the:: [
12 TYLR: [in one event=
13 DAVE: [((points to D&T)) here
14 KYLE: so that story about the (.) campfire (.)
15 [and the table
16 DAVE: [yeah
17 KYLE: they wouldn't have put a campfire down here
18 DREW: and a table up here [on a fault [structure [()
19 DREW: [already [yeah [true:::
20 KYLE: on a pre-existing fault structure [()
21 DAVE: [that's right
22 KYLE: they would have put it= [on a flat ground=
23 DAVE: =[it was down here
24 DAVE: [it was down here=

Excerpt 8: Coordinating participants attention towards relevant features

The rhetorical use of one another's ways of knowing appears to work in compelling agreement/acceptance: each participant presents their interlocutor's argument, e.g., a 'single-event,' while suggesting its inability to explain a given phenomenon, e.g., 'displacing that whole distance in 1954.'²⁶ This can be seen especially well in Tyler's contributions. After a senior geologist, Dave, joins the interaction in ex. 9, Tyler uses an extreme case formulation (Pomerantz, 1986) to emphasize the enormity (and presumably the absurdity) of the type of earthquake that would form the scarp at 1b (lines 48, 51, and 54): "that would be a massive, massive, massive earthquake." Even when referring to a picture provided to the students in ex. 10 (27-30, 32-3, and 5) and conceding that the lower offset (line 1a) could "...potentially be one single event" (36-7), Tyler nevertheless re-emphasizes the unlikelihood of the scarp at 1b being created by a single event, pointing back to the pronounced fault-scarp. Similar to Anna's arguments, we see that the initial knowns, suppositions, etc., are deployed early on in the interaction not for integrating observations or building subsequent conclusions, so much

²⁶ For Kyle, there being multiple events appears to contradict an anecdote related by another instructor: when the fault erupted in 1959, it cut across the campsite creating a 3.2 meter high scarp, leaving a picnic table at the bottom of the scarp and the fire-pit at the top. For Kyle, this story is not sensible if there were multiple events, presumably because that would suggest that people built the campsite plot over a pre-existing, 3-4 meter high fault-scarp.

as they are deployed as already-given conclusions with which their recipients either agree or disagree. Notice, however, that neither participant suggests their interlocutor's premise is false, only that it cannot account for the phenomenon they are invoking as adequately as his own (e.g., 'a single event' does not explain a 5 meter scarp; 'multiple events' do).

(10) jc_14-06-22_hebgen_B_tdk-C

27 TYLR: =dude,
28 TYLR: look at the picture she gave us in the beginning::,
29 TYLR: (.) of the- of the deal
30 TYLR: of this packet
31 KYLE: but that's what (I m-) [why (would) ()]
32 TYLR: [this is right-
33 this is an hour after it happened
34 DAVE: that was down here
35 TYLR: this is an hour after happened
36 TYLR: I think this could potentially be one single event
37 TYLR: this is a couple of hours after it happened
38 TYLR: ok (I th-) and now judging by trees and stuff
39 TYLR: you know that's maybe four or five feet
40 DREW: yeah
41 TYLR: four or five feet
42 TYLR: I don't think that's a single event
43 TYLR: because now it's incised through that

Excerpt 10: Marshalling rhetorical devices in argument

This can be compared to the course of action pursued by the senior geologist, Dave.²⁷ In ex. 9, he asks about the height of the fault-scarp at its lowest point (line 12: 10-15') and highest point (line 25: 18-24'). In excerpt 11, coming just after 10, Dave refers again to the different heights of the scarp (line 1a and 1b). Prior to this, however, he also invokes a number of "givens" for the group (lines 1-7 and lines 16-20), including their being on the footwall. Notice how in the talk verb tense is used to distinguish given content from inferential; in each, antecedents are given in simple present (lines 2 and lines 16-8), while potential consequents are presented in irrealis (lines 5-7, line 20, and line 25): a) "why would

²⁷ The senior geologist's actions in this interaction are of course also guided by pedagogical interests. As such, this interaction is dialectical and not "just" a group of peer geologists working in the field. Nevertheless, the benefit of the disparate levels in expertise is exposing what otherwise might be occluded: the normative practices used to build observations and inferences in geology as a community of practice.

you have...ten feet vertical here and thirty feet vertical over there" and b) "why would you have differential uplift here...to there" and c) "wouldn't you need a terra fault?"

(11) jc_14-06-22_hebgen_B_tdk-D

01 DAVE: so. so::: (are- I-) just say (as)
02 DAVE: are you on the footwall, or the hanging wall.=
03 KYLE: =the footwall
04 DAVE: the footwall, alright
05 DAVE: and why would you have::: >(I think you said)<
06 DAVE: ten feet vertical here,
07 DAVE: and thirty feet verti- over there
08 TYLR: cause this has been cut down by the river
09 KYLE: ((shakes head))
10 DAVE: (do you [see what] I'm saying)
11 KYLE: []
12 DREW: well that was all soft river (sediment) right,
13 DREW: from (running around here before)
14 TYLR: [because there's different terraces ()]
15 DREW: [(cause we're ())]
16 DAVE: [if we're-
17 DAVE: if we- if we're o::n::
18 DAVE: if this is continuous footwall
19 DREW: mm-mh
20 DAVE: why would have differential uplift here and- to there
21 TYLR: because this and that were the same
22 DAVE: [wou-
23 DREW: [it's different sediment types
24 KYLE: [()]
25 DAVE: wouldn't you need a terra fault here
26 DREW: yeah I suppose

Excerpt 11: Directing participants towards normic statements vis-à-vis features in the terrain

In each of these question-answer sequences, the students are selected to account for the differences in height; the terms that he is providing the student in the unrealistic conditions, however (e.g., vertical, differential uplift), are primarily associated with seismic activity. His final question appears to suggest that seismic activity alone could not have produced the differential uplift without the inclusion of a complicating factor such as a "terra fault." In each of the question-answer then, the pursued responses may be the acceptance that in order to explain the apparent difference in offsets between 1a and 1b.

The formulation of the talk--its rhetorical structure (antecedent/consequent), use of tense,

and its being uttered of course by a senior instructing geologist--works in asserting information more than eliciting it.²⁸ Through it, the instructor provides knowns and/or articulates suppositions through propositional content for the participants in his talk, including their standing on the footwall, the footwall continuing over different elevations, and those different elevations not being the result of seismic activity alone. While these propositions do indeed describe "given facts" about the geomorphological processes occurring at the location and in general, they are deployed for agreement. Those that are agreed upon form shared knowns for the subsequent talk, while those disagreed with are presumably dropped..

(12) jc_14-06-22_hebgen_B_tdk-D/E

43 KYLE: all I'm saying I don't think [(this (fault ends))=
44 TYLR: [(it goes out-)
45 it went out that way
46 KYLE: =()
47 KYLE: (abruptly right there)
48 DAVE: oh. no. no. [I don't think anybody's saying that.
49 KYLE: [()
50 DAVE: I think we got the same fault scarp cutting all
51 [the way through here
52 KYLE: [(yes)
53 DAVE: and all the way where we took
54 our second stop today=
55 KYLE: =yeah
56 KYLE: (alright. [then:)
57 DAVE: [so
58 DAVE: so we're seeing the same thing
59 DAVE: we're seeing the same fault scarp

Excerpt 12: We're seeing the same fault scarp

A benefit of doing analysis in the company of others, especially that of senior practitioners, is in allowing for speakers to reveal possible misconceptions. In ex. 12, lines 43 to 46, Kyle formulates his reasoning for withholding agreement: "All I'm saying is that I don't

²⁸ This can also be inferred from Dave's reposing the 2nd question (excerpt 12, lines 16-20) without acknowledging the students' intervening responses to his prior question.

think fault ends abruptly right there," pointing to nearest edge of the pronounced fault-scarp (line 1b). Dave responds by disavowing that "anybody's saying [that one fault ends begins at that spot]" (the corner of lines 1b and 2b). He subsequently affirms and reaffirms the opposite: "I think we got the same fault scarp..." (line 3), "so we're seeing the same thing" (line 11) "we're seeing the same fault scarp" (line 12).

(13) jc_14-06-22_hebgen_B_tdk-E

13 DAVE: [but the question is [(.) [why does this=
 14 DREW: [() [time.=[how many times
 15 DAVE: apparently have ten feet of uplift here
 16 DAVE: (and that) has an aggregate of thirty feet or so
 17 TYLR: be[cause-
 18 DREW: [cause this was already lower
 19 TYLR: because these are the same age=
 20 =as [(this was ())
 21 KYLE: [but they would change the same
 22 KYLE: the footwall and hanging wall would always=
 23 [(.) [have the offset
 24 DAVE: =[()- [change the same
 25 TYLR: same- yeah [at least within the localized [area
 26 DAVE: [(that's right)

Excerpt 13: Establishing hinge proposition

He then immediately reformulates his previous line of question in lines 13, 15, and 16, providing additional "givens": He qualifies the uplift in evidential terms ("apparently"), while describing the larger scarp as an "aggregate." As such, he suggests that the uplift is not self-evident, and requires additional explanation, and he acknowledges that the fault-scarp is the result of multiple events. Notice that these propositions are delivered in simple present. Though they are couched in evidential terms, they are given as factual. As such, while this question appears like the others to provide as much if not more information than it requests, it does constrain what the acceptable "facts" are for consideration, and appears to be used for guiding the students to the relevant questions to be asked.²⁹ Kyle's utterance in line 21 posits

²⁹ This is also suggested by its preface, "but the question is..." The utterance posits the question as something to be considered rather than simply answered.

a premise: changes occur equally along a fault line. Dave responds affirmatively it as factually complementing the argument being pursued; he even attempts a collaborative completion in line 23 and reaffirms the correctness of the assertion in line 26, "that's right." Through the exposition of the participants' position, they are able to posit knowns for agreement. This appears to facilitate collaboration as adversaries are given space to eventually agree to the knowns or articulate their reservations, which in turn allows others to publicly inspect their reasoning.

(15) jc_14-06-22_hebgen_B_tdk-E

27 KYLE: [and so
 28 DAVE: yeah
 29 KYLE: could it be.=that, ehoooooooooooooooo
 30 KYLE: could it be that=
 31 KYLE: when the river started to::: grade itself=
 32 KYLE: back to it's new- well: changed base level=
 33 KYLE: because the base level didn't change
 34 KYLE: the- the elevation changed at this point
 35 KYLE: (and so) () down making that waterfall
 36 KYLE: and now there's a new waterfall
 37 KYLE: [(grading) it all the way back ()]=
 38 DAVE: [oh well
 39 KYLE: =[as it deposited sediment
 40 DAVE: [I mean. it has graded=
 41 DAVE: =all the way there
 42 DAVE: mhm
 43 DAVE: down there, that's the springs [()]-
 44 TYLR: [(so footwall [up)
 45 KYLE: [yeah
 46 DAVE: [yeah

Excerpt 15: Reconstituting narrative reconstruction

Kyle continues the talk, in excerpt 15, incorporating what he previously articulated (namely, that the footwall and hanging wall would always have the same offset) as the premise for his subsequent talk. wherein he attempts to provide a new account for what

happened at the location, albeit with evident trouble.³⁰

(16) jc_14-06-22_hebgen_B_tdk-F

01 DAVE: so that definitely is:: changing
02 KYLE: so it could be::: [jst'f::ill
03 DAVE: [bt- but what's the surface-
04 what's the surface here (that we're on)
05 KYLE: I think this is an old (.) flood plain ()
06 DAVE: [yeah
07 TYLR: [a terrace-
08 TYLR: a terrace
09 KYLE: [yeah
10 DREW: [yeah
11 KYLE: well. ()
12 DREW: yeah=
13 DAVE: =yeah=
14 TYLR: =that's what ()

Excerpt 16: (Re)intregating parts from (re)constituted whole

Dave's intervention in ex. 16 line 3, counters the prior talk with "but" and asks "...what's the surface here that we're on." This has the effect of radically limiting the breadth of the talk from a potential consideration of the river, new vs. old base level, the waterfall, etc. to a much simpler consideration of just what the group is currently standing on: "an old floodplain" or "terrace." The river would have had to previously flowed through that location creating the terrace-scarp at line 2b and eroding away the scarp that previously stood where the upper-lower terrace currently stands.

³⁰ The difficulty that Kyle has in reformulating an updated account even after latching onto a potentially invariable premise (offsets always occurring equally) highlights the importance of temporality in geological description, especially in deciding where to begin. In order for a river "...river to grade itself back" (lines 31-2), there needs to be a prior uplift that displaces it; Kyle recognizes this in his subsequent repair in lines 32-9.

(17) jc_14-06-22_hebgen_B_tdk-E

15 TYLR: but so what if:: what if:::the:::se: (.)
16 these three are the same,
17 TYLR: and this is the different one
18 TYLR: <and this is over> multiple events
19 TYLR: but this is true offset (.) over (.)[(.)
20 DREW: [the one,=
21 TYLR: =the one event=
22 DREW: =but how would that not have offset (.)
23 (in/from) the previous=
24 DREW: =[()
25 TYLR: =[well because (like) if the river
26 was coming around this area
27 TYLR: creating a terrace
28 TYLR: it would have eventually [eroded out] the scarp=
29 KYLE: [eroded out]
30 TYLR: =like the river [over there=
31 KYLE: [(okay) =okay
32 KYLE: yeah=
33 TYLR: =and as [(they're) l- lu-
34 TYLR: [so this whole area got [eroded out
35 TYLR: [as the river
36 wandered around
37 TYLR: it just eventually took out the scarp over
38 KYLE: (agree)
39 TYLR: a thousand years or whatever the difference was
40 between earthquakes.
41 KYLE: [(agree)
42 DREW: [let's write that down

Excerpt 17: (Re)discovering the co-present world as a geologically instantiated world

From here the group reconfigures on the new account in ex. 17 and return back to the topo-map pointing out the stable vs. altered topographies: "these three are the same"; "this is the different one"; "this is over multiple events, but this is the true offset over the one event." This story still explicitly focuses on seismic activity, however, and thus cannot account for the current topography without including erosion processes. Drew's subsequent question in 22-3 problematizes this at least implicitly. Tyler response now incorporates this explicitly: prior to the penultimate event, the river terrace sat at lines 2a and 2b. After that event, the river moved east and eroded the fault-scarp east of the previous terrace-scarp, leaving just a flat floodplain. Kyle agrees to this new account twice (lines 38 and 41), while Drew provides

the most appropriate conclusion to this activity and transition to the next one: "let's write that down."

Conclusion

In this analysis, I argued that the primary impact of the participants' talk in the activity was rhetorical, where participants pursued explanation via agreement on knowns which allowed further collaboration, including subsequent observations and inferences. Productive knowns could be understood along two lines of reference: those productive in mobilizing participants' agreement and those productive in mobilizing subsequent explanation.

Geological reasoning appears motivated via participants' attempts to secure agreement. Whenever participants articulated various propositions, whether in the form of a "given," observation, or inference, while they were often presented without question, if recipients did withhold agreement, display doubt, or actively disagree, then securing or maintaining agreement became the de facto operating principle for the participants. If there was an attempt to posit or evaluate the propositions according to "...some criterion of rationality" it only appeared to come as a consequence of the talk (Mercier and Sperber, 2011, p. 69). This is in line with Mercier and Sperber's (ibid) descriptions of human reasoning, not as being motivated by "truth," but by the attempt to persuade others. In the domain of passive acceptance, that threshold may be insufficient to cause the group as a whole to revise its beliefs (group 1); in more active disagreement, however, the intractability of others positions may force each side to the given arguments (group 2).³¹

As the analysis showed, however, there were other means besides outright disagreement,

³¹ Returning to Mackenzie's abrupt withdrawal in ex. 5, being intractable could also cause participants to withdraw more quickly if either sees themselves at an impasse.

including display doubt, uncertainty, or simply withholding agreement. The effect of displaying doubt as Kate did in ex. 2 and 3 appears to work in putting alternative explanations 'on the table' so to speak, even if they are not seriously considered at that moment, they have been given a public accounting. As such, their re-invocation at later points is made easier; we can similarly suspect that their potential assent by an initial adversary is also made easier: they can agree to it of their own accord and thus realize it independently of any interactional coercion.

Disagreement, even in the form of withholding agreement, is not an inconsequential consideration for participants in any interaction, even if they are not attempting to converge on one solution, as is the case in these interactions. As such, we should explore interactional uses of doubt and uncertainty in scientific discourse and as such, uncertainty should not be treated simply as the lack of certainty. Rather, displays of uncertainty or doubt were shown to be an ordered practice prompting recipients to recognize that their interlocutors hold different beliefs and remediate the discrepant beliefs accordingly.

The benefit of these discursive practices is that they provide in the form of stating knowns, drawing inferences, posing complicating questions, etc., an opportunity not to do disagreement specifically so much as the opportunity to test grounds for agreement. In the first group's interaction, we see that one of the benefits that interaction for the project was in giving the natural phenomena under consideration a greater part to play in the analysis. Initially, the shape designated by line 1a began and remained a river terrace throughout the talk. In this part, the premise was indistinguishable from conclusion. Through Kate's questioning, however, the presence of discrepant features is introduced, allowing the possibility of alternative accounts. This culminated with the introduction of additional

participants.

An analysis of the propositions deployed by the participants outside their rhetorical use is much a more difficult task, as that often depends on understanding how the different propositions relate to one another either in the "natural world" if at all, or in the participants' respective worldviews. The use of propositions, either as knowns, inferences, or conclusions, appeared varied, in some instances they were deployed in a manner similar to syllogism for example (as in Dave's talk in ex. 9, 11, and 13). Other times, the conclusions provided seemed more inferential or at least requires a lesser amount of steps (e.g., the upper fault-scarp is too large for a single event). It is difficult to say how one set of knowns differs from another or why one might be more effective. For instance, Mackenzie's insistence that "it wouldn't make sense for the- a fault just to run and then turn ninety degrees" is altogether given less defense than Anna's premise. As the same time, however, it appeals to the "behavior" of the scarp as a fault following particular norms, and as such does not differ that much from Dave's suggestion that differential offset would be unlikely without additional factors like a "terra fault." There does appear to be a normative framework that makes Mackenzie and Dave's premise more effective in geological explanation. Indeed, the physical relationships between geological processes are at best a proxy for understanding their temporal relationships. As such, Anna's insistence on following the topography may have been detrimental to her eventual explanation, especially when comparing geomorphological processes that exist on such disparate time scales (river changes vs. seismic changes). Attention to these rhetorical practices could benefit research in science, technology, and knowledge studies. Much like Lynch describes visual selective processes, rhetoric interaction "...filters...selects from, simplifies, and orders an initially chaotic world in terms of the

perceiver's projects and interests" (Lynch, 1988, p. 204). This approach may also complement other "textual" approaches in STK studies (Kelty & Landecker, 2009) possibly integrating the propositional content of science with its interactional deployment. Finally, the study of heuristics in science (Solomon, 1992; Tversky & Kahneman, 1974) may benefit from a more grounded approach where cognitive biases can be observed "in the wild" so to speak. It is important to note that knowns were never explicitly deployed in ordered sequences like syllogisms. Altogether, they appeared in a mosaic-type fashion among "like-minded" knowns that even if seemingly supporting one another do not do so hierarchically or programmatically. They are, however, maintained and/or abandoned through their juxtaposition to one another, which can come either via agreement, disagreement, or doubt. Their use, however, appeared to shape the practitioners' analysis of the terrain as much as the geological processes did.

Conclusion

In this dissertation I investigated the interactional, linguistic, and embodied practices that actors use while working and interacting in open, complex wilderness settings. This included what I describe as diagrammatic gestures, that is, the various gestural, graphic, and material practices that practitioners use for depicting, perceiving, and documenting complex geological features, phenomena, and processes in the landscape. I argue that when used as an interpretive tool, these depictions constitute a form of diagrammatic reasoning. The second set of interactional practices that I investigated were those that participants use for making relevant features in the co-present setting so as to make them observable, assessable, and actionable to others particularly in regard to the participants' ongoing courses of action. I argue that these 'noticings' become actionable not primarily in their composition or in their selection of next actions, but rather in directing others' attention towards co-present features that are in turn relevant to the co-participants' collaborative work. The responses that follow in turn emerge as occasioned from both the practice as well as the co-present feature it invokes in the interaction. The significance of the analysis is in demonstrating practitioners' orientation towards the temporal progression of the activities in which they inhabit. Lastly, I investigated how through endogenous pedagogical practices that we see emerge in the field, through which practitioners are socialized into the various reasoning practices integral to geologic practice. As I argued, practitioners routinely orient to different classes of knowables in their explanations: One class is comprised of statements about what is observable and evidentially grounded in the landscape versus those statements that are more *normic* in orientation. These are comprised of statements about what is not observable but taken to be given in the geological process being investigated.

In through the analysis of the different practices analyzed in this dissertation, several general features have been illuminated. The face-to-face interactions between geologists conducting fieldwork in unstructured, heterogeneous, wilderness settings reveal field geology as a particularly perspicuous setting for analyzing complex interactional practices, integral to the practical and professional work that practitioners pursue in collaboration with one another--practices that provide for perceiving, documenting, and reconstructing geological phenomena and processes, as well as synthesizing those into the literary and graphic materials that animate discourse in the geosciences as a community of practice and body of knowledge. On a more fundamental level, this dissertation, further advances the position that action in talk-in-interaction, and language more generically, is not constrained to isolated forms in turns-at-talk, gesture, material practices, or other forms of embodiment, but that these co-operate on one another in the ongoing courses of action and activity and the settings that occasion their use and efficacy. Moreover, the analysis presented in this dissertation reveals how action and interaction more generically is reflexively built from a phenomenal world that is incrementally revealed as consequential, analyzable, categorical through its systematic inclusion and iterative exposition in embodied action and the sequential organization of talk-in-interaction.

Geological reasoning, especially that observed in the field, was argued in the introduction of the dissertation to be an outgrowth of the discipline's particular institutional goals, its given empirical demands, and the recurrent analytical problems that practitioners are faced with solving in their daily work.

The landscapes and geological structures that exist today are the result of the unique histories that contributed to their existence. Geologists work with the objective of explaining

particular entities, that is, a specific outcrop, the Colorado Plateau, the Grand Tetons, and so on, describing their 'life' histories, and detailing the casual circumstances that led to their becoming (Frodeman, 1995, p. 966). In contrast, sciences like physics or chemistry are essentially ahistorical: "particularities of place and time play no significant role in the reasoning process" (ibid, p. 964). So while geology uses explanatory models common to experimental sciences (namely, the deductive-nomological model of explanation), explanatory practices, including generalization, prediction, etc., are not central to geological explanation. Geology "...is not at all concerned with the confirmation or denial of any theory; but it is deeply concerned with the accurate recital of the events of the earth's history" (Kitts, 1963, p. 299). Historical explanation, in turn, necessitates distinct differences in the reasoning practices that practitioners use for accomplishing this. Accordingly, "retrodiction, not prediction, is the most characteristic geological inference." (Kitts, 1976, p. 38)

Retrodiction, that is, the enumeration of the events thought to give rise to a given entity in the landscape, carries its own empirical issues--primarily in how events in the past are inferred: While the geologist may "see" past events in the landscape, "...the propositions with which historical inferences begin are not themselves historical but are instead assertions about the present" (Kitts, 1976, p. 38). Conflating the two becomes problematic where the onlooker confuses the mechanics of a given geological process with its preservation or lack thereof in the geological record. The inferences that retrodictions rely on, however, can only be made about the presence of the traces that vouch for a given system; they cannot be used such that the absence of a trace necessarily means that the system did not occur. Central to historical explanation, is the fact that the present provides an incomplete picture of the past: Most geological processes are not directly observable as they occur over spans of time much

longer than the whole of human civilization let alone modern institution or an individual's life. Evidence of past events tends to be erased through time. Consequently, the geological record is rarely preserved, resulting in large gaps in the stratigraphic record and incomplete data. Geological explanation, both in publications and in the interactions observed in this data, always orient to the possibility of "boundary conditions," i.e, the conditions that cannot be accounted for in an explanation (Kitts, 1976, p. 32). Even in the absence of boundary conditions, we nevertheless see a 'disciplined skepticism' on the geologist's part: "Geologists are apparently more inclined to suppose that the same antecedents have different consequences than to suppose the contrary. A geologist will maintain that it is not really true that different initial conditions may result in indistinguishable subsequent states, it only seems to be true." (Kitts, 1976, p. 43).

Due in large part to these institutional goals, empirical conditions in fieldwork, and the general epistemological outlook that emerge, we see geologists in the field employ a number of interactional, inscription, and reasoning practices for investigating geological phenomena. We see this in both their use as well as their instruction.

Geological reasoning is essentially interpretive and hermeneutic: a landscape, like a text, can be interpreted as a system of signs, whose deeper meanings must be deciphered via investigation (Frodeman, 1995). This reasoning unfolds iteratively in a circular manner: "our understanding of an outcrop is based on our understanding of the individual beds, which are in turn made sense of in terms of their relationship to the entire outcrop" (ibid, p. 963). This circularity does not preclude geologists from accurately describing geological phenomena, nor does it stop them from comparing competing descriptions. While a geologist's perception of an object is influenced via the tools and concepts he or she brings into the field, that

perception is not solely determined by these--"objects assert their own independence" (ibid, p. 963) as Frodeman states succinctly. An outcrop onto itself, however, means nothing to the "uninitiated" before a practitioner instructs him or her on how to first 'see' the rock" (1995, p. 963).

Narrative plays a crucial role in geological reasoning and practice. Frodeman, emphasizes Ricoeur's (1985) argument that narrative is one of the most basic way humans have for constituting experience and making sense of it: "Scientific explanation is based on narrative in the sense that, through telling a story, we create a context that defines and gives meaning to our research and data" (ibid, p. 966). Narratives in turn advance understandings by forcing the details of an event into generalizations but by integrating it within a meaningful temporal sequence. Iteration is fundamental to geological reasoning as a whole, and replete throughout the excerpts analyzed in this dissertation: While the geologist relies on the initial conception of an object as criteria for making sense of it, the provisional interpretation that emerges are questioned when they conflict with the "...details in the object (or text) that do not jibe with [its] overall conception...[forcing]...us to revise our interpretation of the whole as well...other particulars." (Frodeman, 1995, p. 163). Our understanding deepens further the longer these iterations persist, and within each cycle, our understanding of the whole effects the meanings conditioned by its parts which in turn reveals new understandings of the whole.

Many of the assertions made in geology, as a historical science, are importantly distinct from generalizations or probabilistic statements, but rather are more *normic* in nature. In contrast to the probabilistic assertions, the (un)certainly projected in a normic assertion applies to the entire scope of the assertion, as specified by the geologist, *except for those conditions where special conditions may apply* (Scriven 1959a in Kitts, 1976). While the

special conditions may invalidate the claim are not specified, their phrasing and qualification makes an appeal to the reader (or recipient) to attend to that possibility and operate on the judgement of their reader (or recipient) as members of the same community of practice. Kitts (1976) argues that normic formulations are most useful "...where the system of exceptions, although perfectly comprehensible in the sense that one can learn how to judge their relevance, is exceedingly complex" (ibid, p. 37). Importantly, for the story being told about geological practice here, and for the analyses that this dissertation pursues in the subsequent chapters, (un)certainty does not emerge as a function of the probability formulated in the talk and otherwise; neither does it emerge as a deficiency in the practitioners' current understanding; rather (un)certainty emerges as a fundamental epistemic stance taken by the practitioners analyzed here and, moreover, a way of knowing that they contribute in addition to whatever they can explicitly assert about a given object of analysis. In contrast to the argument that "the hermeneutic and perceptual aspects of geological work largely on the pre-reflexive level, i.e., they are not aware of them" (Raab & Frodeman, 2002, p. 71), in contrast, the interactions investigated here show participants to orient quite explicitly to the iterative and perceptual work of their actions.

Appendix

Appendix A

Transcription glossary

The transcription glossary is based on the system developed by Gail Jefferson and is used in the [large](#) majority of conversation analytic publications (see Atkinson & Heritage (eds.) 1984: ix-xvi, Steensig 2001: 33-37). Below [is a glossary of the transcription symbols used in this dissertation](#):

Speaker/actor notation: Line numbers, speaker(s) and other information are in the left margin:

- 01, 02 *Lines are numbered so as to be easily referred to in the text.*
- A: *Speaker names (often abbreviated) show who is the speaker of the utterance or performer of the action.*
- (A): *If the speaker's identity is uncertain, the name of the speaker*
(): *is enclosed in paren. If unknown, then paren are empty*
- >> *Arrows indicate the lines of focus in the text.*

Temporal notation: Duration of pauses, gaps, relative timing of overlap onset and offset, relative pace of speech, and speech elongation

- (.) (1.4) *Silences are shown in tenths of a second in paren. Silences less than 0.2, a "micropause," are marked with a full-stop.*
- = *Equal signs indicate one speaker's talk latched onto a prior speaker's talk with no intervening silence. May also indicate that two lines from the same speaker are through-speech even though there is a line break.*
- Hel[lo]
 [hi] *Square brackets indicate overlapping talk. Start of overlap is marked precisely; if possible end of the overlap is marked also.*
- >text<, <text> *Arrows - facing towards text indicate talk delivered at a relatively quicker pace; facing away from text indicate talk delivered at relatively slower pace;*
- <<text *Arrows only placed on left side of utterance indicate rushed onset.*
- no:, no::: *Colons indicate the preceding sound is extended.*

Commentary: Transcriber's commentary on or uncertainty about transcription is marked either with paren or double-paren:

(what)	<i>Transcribed talk is suspected but not known for certain</i>
()	<i>Comments on what happens or how something is done or said.</i>
((nods))	<i>Sometimes description of physical activities is written down in italics.</i>

Sounds: Regular orthography is used but modified to indicate sounds that regularly occur in speech.

so-	<i>A dash indicates an abrupt cut-off to the prior sound in a word.</i>
hh, yeahh, .hh	<i>An 'h' (or series thereof) indicates out-breath; if preceded by a full-stop, an in-breath is indicated.</i>
yeah(h)h	<i>An 'h' enclosed in paren indicates "breathy laughter."</i>
.mph, .tsk, tsh	<i>A series of consonants indicates 'clicking' sounds with the mouth; if preceded by a full-stop, an ingressive production (made with in-breath) is indicated</i>
heh heh	<i>Laughter is marked using standard (English) convention.</i>
#yeah#	<i>The 'pound' (or British 'number') sign indicates creaky voice.</i>
£smile£	<i>The British pound sign indicates 'smile voice.'</i>

Prosody: volume, emphasis/stress, prosodic rises and falls, and voice quality

<u>emphasis</u>	<i>Underlining indicates speaker emphasis.</i>
↑high	<i>Upward arrows indicate a marked prosodic rise.</i>
↓low	<i>Downward arrows indicate a marked prosodic fall.</i>
°quiet°	<i>Degree signs mark low volume or possibly even whisper.</i>
LOUD	<i>Capital letters indicate high volume.</i>

Intonational contours (approximate):

. , ? _	<i>Full-stop marks a sentence-final or terminal intonation; a question mark indicates rise to high intonation; a comma indicates a rise to mid or continuing intonation; an underscore indicates a flat intonation</i>
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