Lawrence Berkeley National Laboratory
Recent Work

Title
AN ALUMINA COLUMN Rb-82 GENERATOR

Permalink
https://escholarship.org/uc/item/3gc2p05p

Author
Yano, Yukio

Publication Date
1977-10-01

eScholarship.org
Powered by the California Digital Library
University of California

Presented in part at the 2nd Western Regional Meeting of the Society of Nuclear Medicine, Las Vegas, NV, October 20 - 21, 1977; also Submitted to International Journal of Applied Radiation and Isotopes

LBL-7422 c.2

AN ALUMINA COLUMN Rb-82 GENERATOR

Yukio Yano and Eugene P. Roth

DONNER LABORATORY

October 1977

Prepared for the U. S. Department of Energy under Contract W-7405-ENG-48

TWO-WEEK LOAN COPY

This is a Library Circulating Copy which may be borrowed for two weeks. For a personal retention copy, call Tech. Info. Division, Ext. ~~5716~~ 6782

LAWRENCE BERKELEY LABORATORY UNIVERSITY OF CALIFORNIA BERKELEY

LBL-7422 c.2

DISCLAIMER

This document was prepared as an account of work sponsored by the United States Government. While this document is believed to contain correct information, neither the United States Government nor any agency thereof, nor the Regents of the University of California, nor any of their employees, makes any warranty, express or implied, or assumes any legal responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by its trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof, or the Regents of the University of California. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof or the Regents of the University of California.

An Alumina Column Rb-82 Generator

Yukio Yano and Eugene P. Roth

Donner Laboratory and Lawrence
Berkeley Laboratory, University of
California, Berkeley, California 94720

ABSTRACT

The use of an alumina column for the adsorption of radioactive Sr for the generator production of 75 sec Rb-82 was evaluated in both batches and column experiments using Sr-85 and cyclotron-produced Sr-82. Comparisons of alumina, Bio-Rex 70 and Chelex 100 ion exchangers were made to determine Sr adsorption, Rb-82 elution yield and Sr breakthrough. The adsorption of Sr is similar for alumina and Chelex 100 but different for Bio-Rex 70. Alumina and Chelex 100 exhibit a small fraction of poorly bound Sr which appears as higher breakthrough in the early elution volumes. The remaining Sr activity is strongly bound to these ion exchangers and the breakthrough remains stable at a lower breakthrough value through a large number of elutions. Bio-Rex 70 on the other hand does not exhibit the poorly bound Sr fraction and the breakthrough of Sr remains the lowest of the three ion exchangers through a moderate number of elutions and then the Sr breakthrough gradually increases with each additional elution.

Work supported by the U. S. Department of Energy.

INTRODUCTION

The application of improved positron detectors for transverse section tomography in nuclear medicine is dependent on the availability of short-lived positron emitters which permit rapid accumulation of data without delivering a high radiation dose to the patient[1-4]. Radionuclide generators which deliver many millicuries of short-lived radioactivity from a long-lived parent radioisotope offer an economical and convenient supply of radionuclides. The purpose of this study was to evaluate the breakthrough characteristics of Sr-82/85 from an alumina column Rb-82 generator which can deliver multimillicurie amounts of 75 sec Rb-82 for positron imaging and quantitation of blood flow through the myocardium, brain or kidneys. Either bolus or continuous infusion techniques can be used to measure accumulation or washout.

Previous work with Bio-Rex 70, a weakly acidic cation exchanger,[5-8] and Chelex 100[9], a chelating ion exchange resin, indicate that a good separation of Rb-82 from Sr-82 can be obtained, however, the former ion exchanger begins to increase in Sr breakthrough after long-term elutions with 2% NaCl at pH 7-8, while the latter resin requires an NH_4OH - NH_4Cl buffer at pH 9.0 as the eluent solution which is not desirable for intravenous infusion. Furthermore, both Bio-Rex 70 and Chelex 100 are organic ion exchange resins which are subject to radiation damage. Although these ion exchange resins are useful for the Rb-82 generator, improvements might result from the use of an inorganic ion exchanger such as alumina (Al_2O_3) which is more resistant to radiation damage in the 2-3 month useful life of a Rb-82 generator.

In our studies with alumina for the adsorption of Sr-82/85 and the elution of Rb-82, we modified the procedure of Kopecky and Mudrova for the separation of Sr-85 from an irradiated RbCl target[10].

METHODS OF PROCEDURE

Reagents and Equipment

The Sr-82 used in these studies was produced at the Lawrence Berkeley Laboratory 88-inch cyclotron by the $^{85}Rb\ (p,4n)^{82}Sr$ nuclear reaction. Some studies for batch and column breathrough of radioactive Sr were also done with commercially available Sr-85. The ion exchangers used in this study were Bio-Rex 70 in Na form*, Chelex 100*, and basic alumina*. Eluent solutions were made up from reagent grade chemicals and included 2% NaCl at pH 7-8 for Bio-Rex 70, 0.1 M NH_4OH + 0.1 M NH_4Cl at pH 9.0 for Chelex 100 and 2% NaCl at pH 9.0 for the alumina column.

Procedures

Batch studies were done with the three ion exchangers using Sr-85. One gram each of alumina, Bio-Rex 70 and Chelex 100 were weighed into three separate 15 ml centrifuge tubes and equal amounts of Sr-85 activity were added to the tubes. After centrifugation the activity in the supernatant was determined relative to the Sr-85 on the ion exchanger by counting in a NaI(Tl) well-counter. The percent Sr-85 adsorption to the ion exchangers was determined for 15 minutes and 24 h after contact with the ion exchanger. Washing or breakthrough of Sr-85 from the ion exchange materials was determined by adding 10 ml of eluent solution to the centrifuge tubes, shaking, centrifuging, separating, and counting the activity both in the supernatant and on the ion exchanger.

Column studies were done by loading the ion exchanger in a 1.0 ml volume stainless steel column as previously described[8] and loading the column with Sr-85 solution. The percent breakthrough was determined for the loading step and for subsequent elutions with the appropriate eluent solution. Ten or 50 ml elution volumes were collected and counted to give breakthrough as

$$\frac{\text{counts/min Sr in eluate}}{\text{counts/min Sr on the column}}.$$

---

*Bio-Rad Laboratory, Richmond, Ca.

Similar column studies were done with Sr-82 in which the activity on the column was determined by assaying in an ionization chamber dose calibrator. The yield of Rb-82 for each elution with 10 ml of 2% NaCl was determined by assaying the Rb-82 activity and correcting for decay to the time of the end of the elution. After allowing the Rb-82 activity to decay away, the Sr-82 breakthrough was determined for each elution by counting the eluate in a well-counter. The total counts/min of Sr-82 on the resin column was determined by counting a standard solution of Sr-82 and calculating the total counts/min of Sr-82 on the column from the assayed activity of Sr-82. The breakthrough of Sr was determined for three separate loadings on alumina with long-term elutions of up to 2-3 liters of eluent solution for each loading.

Results and Discussion

The results of the batch studies with Sr-85 and the three ion exchangers are shown in Table I. For the short contact time of 15 minutes for the ion exchanger and Sr activity, the percent adsorption is very nearly the same for all three ion exchangers with the breakthrough of Sr-85 also nearly the same, namely $1.5 - 6 \times 10^{-3}$. However, at the longer contact time of 24 hr, the breakthrough from alumina decreased by a factor of 350, from Bio-Rex 70 a 26-fold decrease, and from Chelex 100 a decrease of 1000-fold. This would indicate that the firm binding of Sr to alumina or Chelex 100 requires an incubation period. During the washing phase there appears to be a significant decrease in Sr breakthrough from alumina and Chelex 100 while the Sr breakthrough from Bio-Rex 70 is relatively unchanged. These breakthrough results apparently confirm the poorly bound Sr activity which initially wash off in the early wash fractions and then stabilize at some lower breakthrough value. After the initial washes the breakthrough of Sr was smallest from alumina followed by Chelex 100 and then by Bio-Rex 70.

The results from the generator column studies with Sr-85 are shown in Fig. 1, which compares breakthrough of Sr-85 from alumina and Bio-Rex 70 for 50 ml elutions.

After the initial elution the breakthrough of Sr-85 is about an order of magnitude less from Bio-Rex 70 compared to alumina until about one liter of eluent solution has been put through the column at which point the breakthrough from Bio-Rex 70 starts to increase and the breakthrough from alumina decreases. These results from column elutions are different from the batch experiment but they indicate the same conditions. Namely a partial poorly bound Sr-85 to alumina which represents the activity easily removed by rapid flow of the eluent solution through the alumina. After this leaching phase the breakthrough from alumina stabilizes at a lower value. The Bio-Rex 70 column behaves differently in that the Sr-85 is more uniformly and strongly bound to the resin and is not as easily leached from the column, however, the total Sr activity migrates slowly down the resin column with successive elutions until a point is reached at which the breakthrough of Sr begins to steadily increase.

Earlier results with Chelex 100 indicated a Sr breakthrough characteristic similar to alumina[9]. Other earlier studies also indicated a method to prolong the useful life a Bio-Rex 70 generator by using an easily exchangeable trapping column connected in line with the main generator column[8].

The results of different saline concentrations from 0.9% to 3.0% for elution yields of Rb-82 and Sr breakthrough from an alumina column generator are shown in Table II. The yield of Rb-82 is directly related to the NaCl concentration while the breakthrough of Sr-82 appears to be relatively independent of the saline concentrations up to 3%.

Breakthrough of Sr-82 for large volumes of 2% NaCl at pH 9.0 put through alumina column generators are shown in Figure 2. These results indicate an early washing phase for Sr-82 and then a lower and stabilized breakthrough value of about 10^{-5} for up to 3.0 liters of eluent volume which would be equivalent to 300 elutions. This compares with an earlier breakthrough value of about 1×10^{-8} as the best obtainable with Bio-Rex 70[8].

If 100 mCi of Sr activity is on the column, then a maximum breakthrough value of about 10^{-6} is desirable to deliver less than a μCi of Sr per elution. Under these requirements an alumina column Rb-82 generator is on the borderline of being acceptable for Sr-82 breakthrough. However, the stability to breakthrough changes with large cumulative elution volumes is an advantage as is the greater resistance to radiation damage. In order to inusre a 70-80% yield of Rb-82 per 10 ml elution volume, it is not practical to increase the volume of the alumina column to decrease the breakthrough of Sr-82, however, it might be possible to decrease the Sr-82 breakthrough by allowing the Sr-82 to remain in contact with the alumina for a period of 24 hr before elutions are begun.

When high levels of Sr-82 activity are obtained from the Los Alamos Meson Production Facility (LAMPF)[11], the usefulness of radiation-resistant alumina can be evaluated over the 2-3 month useful life of a Rb-82 generator.

References

1. Burnham C.A., and Brownell G.L. IEEE Trans. Nuc. Sci. 19, 201 (1972).

2. Phelps M.E., Hoffman E.J., Mullani N.A., et al. Non-invasive brain imaging, computed tomography and radionuclides, Society of Nuclear Medicine, New York, p. 87 (1975).

3. Derenzo S.E., Zaklad H. and Budinger T.F. J. Nuc. Med. 16, 1166 (1975).

4. Chou Z.H., Chan J.K. and Erickson L. IEEE Trans. Nucl. Sci. 23, 613 (1976).

5. Yano Y. and Anger H.O. J. Nuc. Med. 9, 412 (1968).

6. Budinger T.F., Yano Y. and Hoop B. J. Nuc. Med. 15, 429 (1975).

7. Hoop B., Beh R.A., Beller G.A., et al. IEEE Trans. Nucl. Sci. 23, 584 (1976).

8. Yano Y., Chu P., Budinger T.F., et al. J. Nuc. Med. 18, 46 (1977).

9. Grant P.M., Erdal B.R., and O'Brien H.A. J. Nuc. Med. 16, 300 (1975).

10. Kopecky P. and Mudrova B. Int. J. Appl. Radiat. Isotopes 25, 469 (1974).

11. Grant P.M., O'Brien H.A. and Kahn M. J. Inorg. Nucl. Chem. 37, 413 (1975).

Figure Captions

Figure 1. Breakthrough of Sr-85 for 50 ml elutions with 2% NaCl at pH 9.0 from an alumina column and a Bio-Rex 70 column.

Figure 2. Breakthrough of Sr-82 from two alumina column generators for Rb-82 using 2% NaCl at pH 9.0.

TABLE I

Sr^{85} Batch Studies with Alumina Bio-Rex 70 and Chelex 100

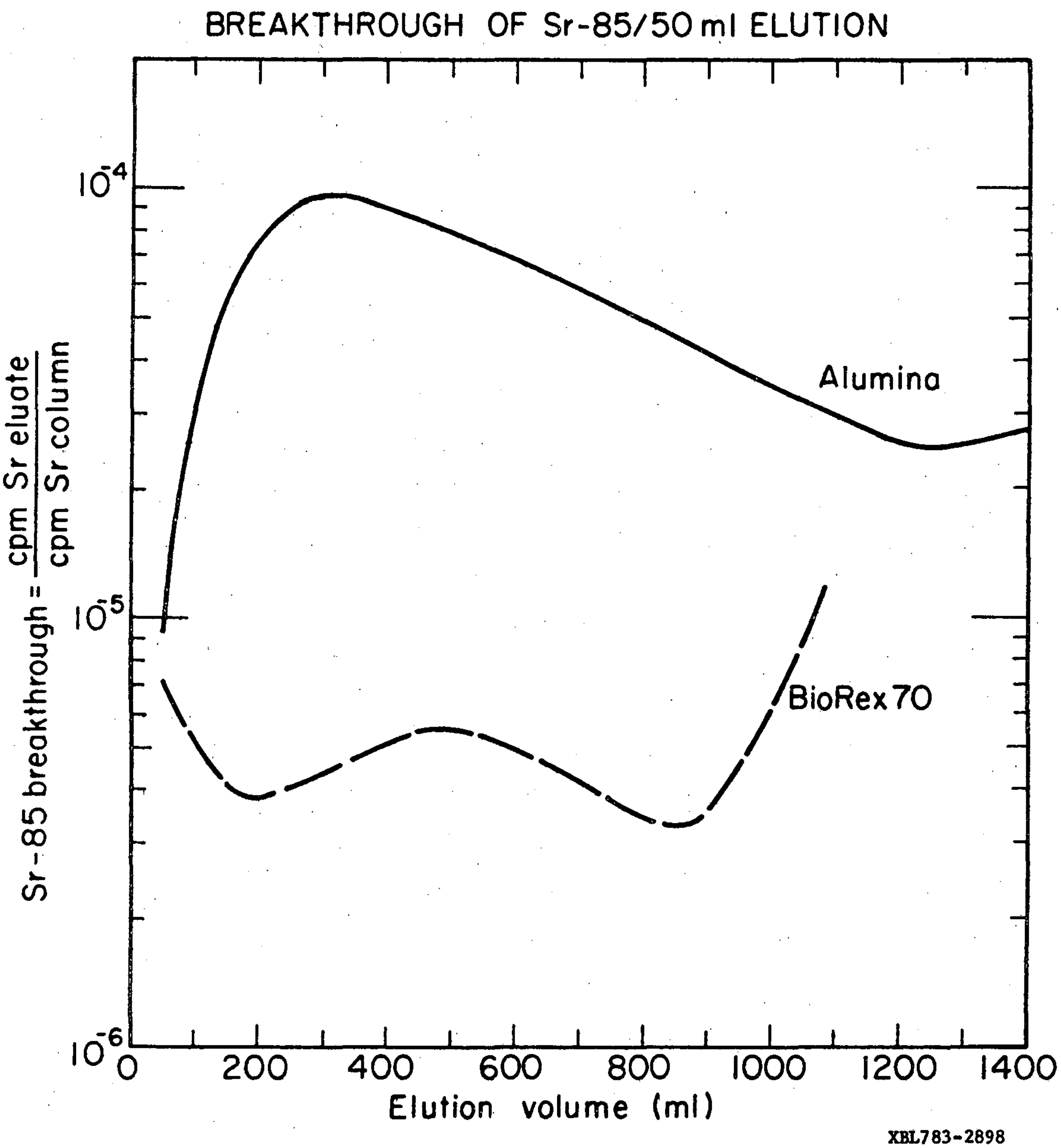
	Al_2O_3 (Basic)	Bio-Rex 70 (Na form)	Chelex 100 pH 9.0 (NH Cl+NH OH)
Sr-85 μCi	2.7 μCi	2.7 μCi	2.7 μCi
Loading (%) Adsorbed	99.8%	99.8%	99.8%
Elution (ml)	Breakthrough		
0 - 5	1.35×10^{-3}	3.89×10^{-3}	6.00×10^{-3}
6 - 10	8.21×10^{-4}	2.97×10^{-3}	4.63×10^{-3}
15	2.12×10^{-4}	7.17×10^{-4}	1.97×10^{-3}
20	2.28×10^{-4}	1.74×10^{-3}	3.48×10^{-4}
25	5.36×10^{-4}	1.57×10^{-3}	8.45×10^{-4}
30	2.20×10^{-4}	1.29×10^{-3}	3.21×10^{-4}
35	2.27×10^{-4}	1.16×10^{-3}	7.74×10^{-4}
24 hr incubation (5 ml wash)	3.90×10^{-6}	1.51×10^{-4}	6.20×10^{-6}

$$\text{*Breakthrough} = \frac{\text{CPM Supernatant}}{\text{CPM Total Column}}$$

TABLE II

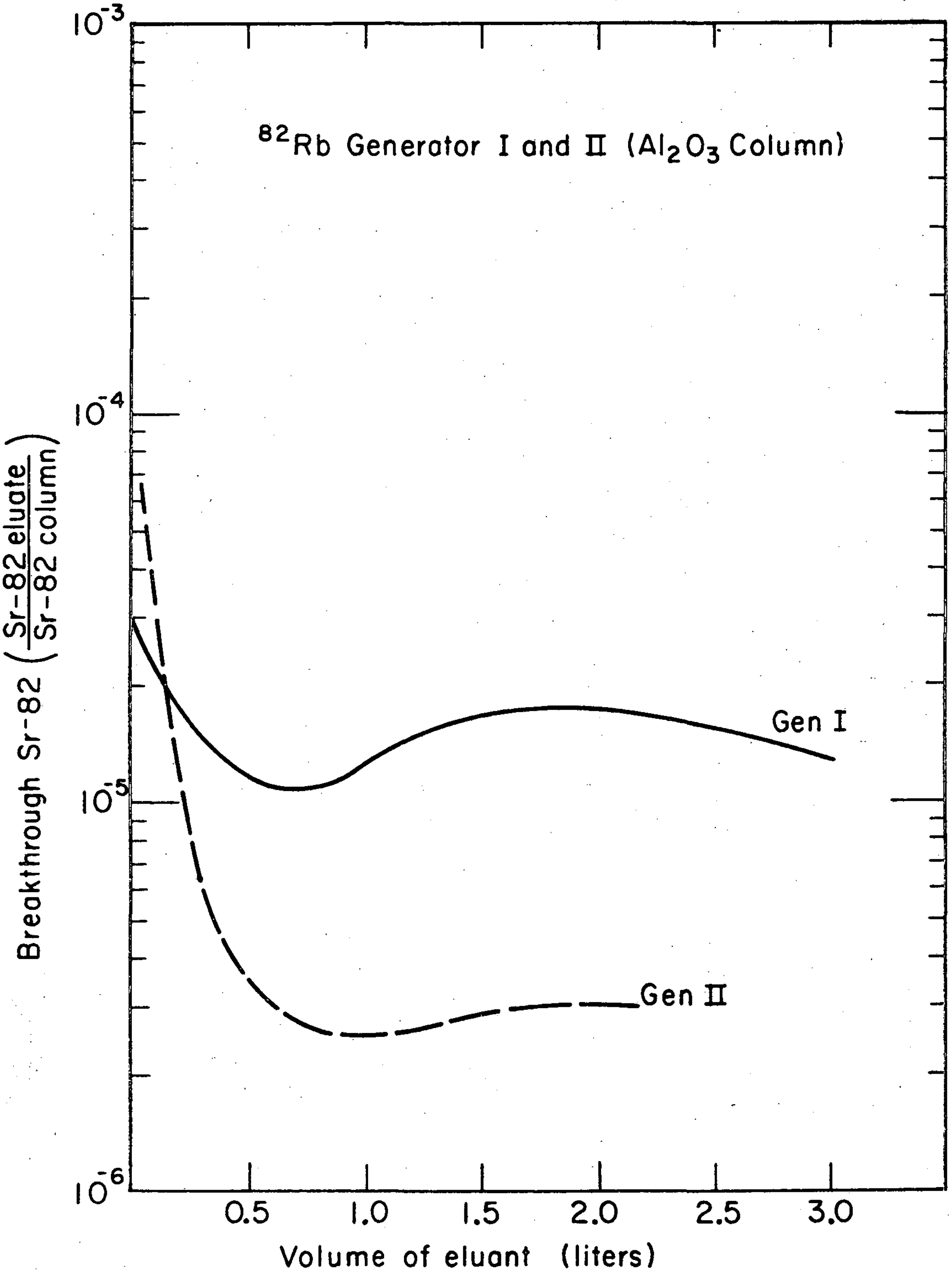
Rb-82 Elution Yield and Sr-82 Breakthrough
From an Alumina Column Rb-82 Generator

%NaCl @ pH 9.0	% Yield Rb-82	Breakthrough Sr*
0.9	28.6	2×10^{-5}
0.9	24.4	9×10^{-5}
0.9	24.7	8×10^{-5}
2.0	71.2	6×10^{-5}
2.0	70.2	4×10^{-5}
2.0	65.2	2×10^{-5}
3.0	96.5	3×10^{-5}
3.0	81.0	2×10^{-5}
3.0	78.8	3×10^{-6}



BREAKTHROUGH OF Sr-85/50 ml ELUTION
Sr-85 breakthrough = cpm Sr eluate / cpm Sr column
10^{-4}
10^{-5}
10^{-6}
Alumina
BioRex 70
0
200
400
600
800
1000
1200
1400
Elution volume (ml)
XBL783-2898

Fig. 1



XBL779-3803

Fig. 2

This report was done with support from the Department of Energy. Any conclusions or opinions expressed in this report represent solely those of the author(s) and not necessarily those of The Regents of the University of California, the Lawrence Berkeley Laboratory or the Department of Energy.

TECHNICAL INFORMATION DEPARTMENT
LAWRENCE BERKELEY LABORATORY
UNIVERSITY OF CALIFORNIA
BERKELEY, CALIFORNIA 94720