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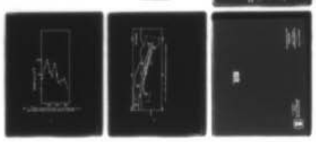

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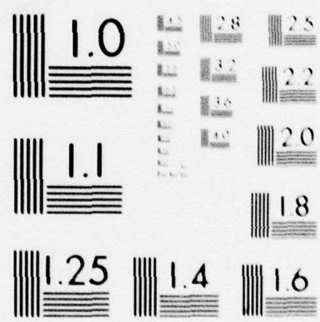

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NRL Memorandum Report 3941

Measurements of Atmospheric ^{222}Rn at San Nicolas Island and Over Nearby California Coastal Areas During CEWCOM-78

R. E. LARSON, W. KASEMIR,

Atmospheric Physics Branch
Ocean Sciences Division

and

D. J. BRESSAN

Geochemistry Section
Ocean Sciences Division

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20. ABSTRACT (*Continue on reverse side if necessary and identify by block number*)

Shipboard and island measurements show that clean maritime air prevailed over San Nicolas Island, California, for two periods of a day or more each during the twelve days of data collection and moderately continental air prevailed for the remainder of the time. Moderately continental air was encountered out to 200km from shore on 8 and 9 May on a dogleg course from Monterey to the San Nicolas Island area. Maritime air was encountered throughout the direct return trip along the coast, showing that the relative continental/maritime nature of the air at a given location in the area is more dependent upon prevailing winds than on distance from land. → next page (Continues)

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20. Abstract (Continued)

cont → Radon measurements at the NRL tower site on San Nicolas Island were in good agreement with shipboard data throughout the area, suggesting a relatively uniform distribution of air over a large area, whether it be maritime or moderately continental. The moderately continental conditions prevailing at San Nicolas Island are not unlike those previously encountered for one or more days in remote Pacific areas in air of Asian origin.

CONTENTS

INTRODUCTION

Measurements of atmospheric ^{222}Rn provide a simple, reliable, real-time indicator of the relative maritime/continental nature of over ocean air. Radon (^{222}Rn) is a radioactive rare gas with a half life of 3.86 days and is the daughter product of ^{226}Ra present in all soils and rocks. Radon emanates from all land areas in quantities that are dependent upon the amount of radium (^{226}Ra) in the soils and rocks and its escape-to-production ratio. Radon concentrations at a few meters height over land areas are typically of the order of one hundred to four hundred p Ci m^{-3} (Lambert et al., 1976; Rangarajan et al., 1974). Radon emanation from the oceans is about three orders of magnitude less than from land (Lambert et al., 1972) and can be neglected for our purposes.

North Atlantic and North Pacific maritime air usually contains 1 to 4 p Ci m^{-3} radon and associated small quantities of insolble dust and other materials of continental origin (Larson et al., 1972; Bressan et al., 1974), however, radon concentrations of less than a few tenths p Ci m^{-3} have been measured over oceans (Wilkniss et al., 1973). Pulses of radon of 10 to 20 p Ci m^{-3} concentration with durations on the order of a day are not unusual even over remote ocean areas (Larson et al., 1975; Wilkniss et al., 1978, 1979). These pulses are accompanied by high concentrations of materials of continental origin and tend to be associated with frontal areas or other air mass boundaries (Larson, 1978; Larson and Bressan, 1979).

The exact quantity of radon (within a factor of two or three) is less significant than changes in concentration. This is due to the many variables which affect the exact quantity of radon emanated into the air from a given area (Israelsson et al., 1973; Clements and Wilkening, 1974; Wilkening et al., 1972; Wilkening, 1974), its subsequent distribution within the air mass, and its removal mechanisms (Birot et al., 1970; Guedalia et al., 1973; Lopez et al., 1974). Therefore, the precision in determining the real-time changes in the radon concentration is emphasized over the accuracy of the measurements. The measurement techniques used for this experiment (Larson, 1973; Larson and Bressan, 1978) are based on methods developed earlier at this laboratory (Lockhart and Patterson, 1964) and emphasize simplicity, reliability, and rapidity of sampling.

RESULTS AND DISCUSSION

Individual radon data points are shown in Figures 1 and 5. Data from the ARC (Automatic Radon Counter) aboard the R/V ACANIA is shown as a solid line connecting the data points. Crosses represent data collected on a tower located on the Northwest tip of San Nicolas Island. The tower was 20 meters from the surf and samples were collected 6 meters above the ground. Three hourly radon averages as well as cruise tracks are shown in Figures 2, 3, and 4.

Note: Manuscript submitted December 20, 1978.

Radon concentrations have been found to correlate well with concentrations of other materials of continental origin (Larson et al., 1972). There was good correlation observed between concentrations of radon and that of other materials of continental origin throughout the cruise, but detailed comparisons have not been made and are beyond the scope of this report.

The fluctuations in radon concentration show extremes of 4 and 155 p Ci m^{-3} at Monterey, which illustrate the effects of onshore and off shore winds in port. Radon decreased as the ACANIA headed away from land on a course of 225° on 8 May. Note that the minimum radon was measured about two hours before R/V ACANIA reached the most distant point from land and changed course to 105°. Although surface winds were from the Northwest, air with significant continental components began to replace the maritime air after 2200 hours on 8 May. Maritime air was encountered on 10 May although the R/V ACANIA was closer to land than the previous day. Low radon concentrations were also measured at San Nicolas Island on 10 May (see Table of Figure 3). There was substantial continental material in the air from May 11 through 14, with the highest radon measured on 12 May when the R/V ACANIA was closer to land.

A substantial drop in the radon concentration measured aboard the R/V ACANIA on the afternoon of 14 May was coincident with a very noticeable increase in visibility and westerly winds. Maritime radon levels persisted through the 15th while the ship as anchored near San Nicolas Island. High winds and waves required the R/V ACANIA to depart San Nicolas Island and proceed to the lee of Santa Rosa Island, where moderately continental radon was recorded. Continental radon levels were observed at Port Hueneme late on the 16th and again on the 18th under Santa Anna conditions. Moderate radon concentrations and continental influences dominated the four day period while the R/V ACANIA returned to and remained near or upwind of San Nicolas Island. The spike on 21 May represents a radon sample taken while the ship was in the lee of Santa Rosa Island (during transit between Santa Rosa and Santa Cruz Islands), apparently showing a local radon source on that island.

On the afternoon of 22 May the R/V ACANIA was again forced to abandon the experimental areas upwind of San Nicolas Island because of high winds. The 22-24 May were spent in the relatively sheltered Santa Barbara Channel, when higher radon concentrations (Figure 5) were recorded closer to Santa Barbara (Figure 6) and lower concentrations closer to Pt. Conception. This illustrates either the increase of atmospheric radon with time over land or a mixing of maritime air with increasing quantities of continental air. Although the winds measured at the ship in the Santa Barbara Channel were westerly, further from shore and at higher altitude, winds were northwesterly. The radon levels between Pt. Conception and Monterey on 24 and 25 May were substantially less than those encountered throughout most of the earlier seaward legs of the triangle. This further demonstrated that the prevailing winds are more important than distance from shore in determining the continental contribution to over ocean air.

The good agreement between island and ship radon data, when they were substantially separated, suggest that large scale circulations, and herce relatively uniform air, prevailed in the area.

CONCLUSIONS

Very clean maritime air prevailed at San Nicolas Island for two and a half days of the twelve-day period of data collection and a moderate influence of continental air prevailed throughout the remainder of that period. The exact origin of the continental air is obscure, because high levels of continental material from Asian dust storms have been observed over mid-Pacific areas by Jackson et al. (1973). Also, radon concentrations similar to those measured at SNI were observed near Hawaii over a two-day period in 1974, and those could be corrected for decay and traced to an Asian origin (Larson et al., 1975; Wilkiness et. al., 1979).

The good correlation between data gathered from 6 meters over the ocean (on the R/V ACANIA) and the data from 6 meters above coastal land (on the NRL tower) indicates the rather uniformly distributed air off the southern California coast during the period of our investigation.

The brief period of CEWCOM 78 cannot be considered indicative of the year, of for that matter, even of May, due to long range transport and local variability. Routine sampling over a period of a few years (as is done for rainfall) would really be necessary to gain a complete picture of the general level of continental materials in over ocean air.

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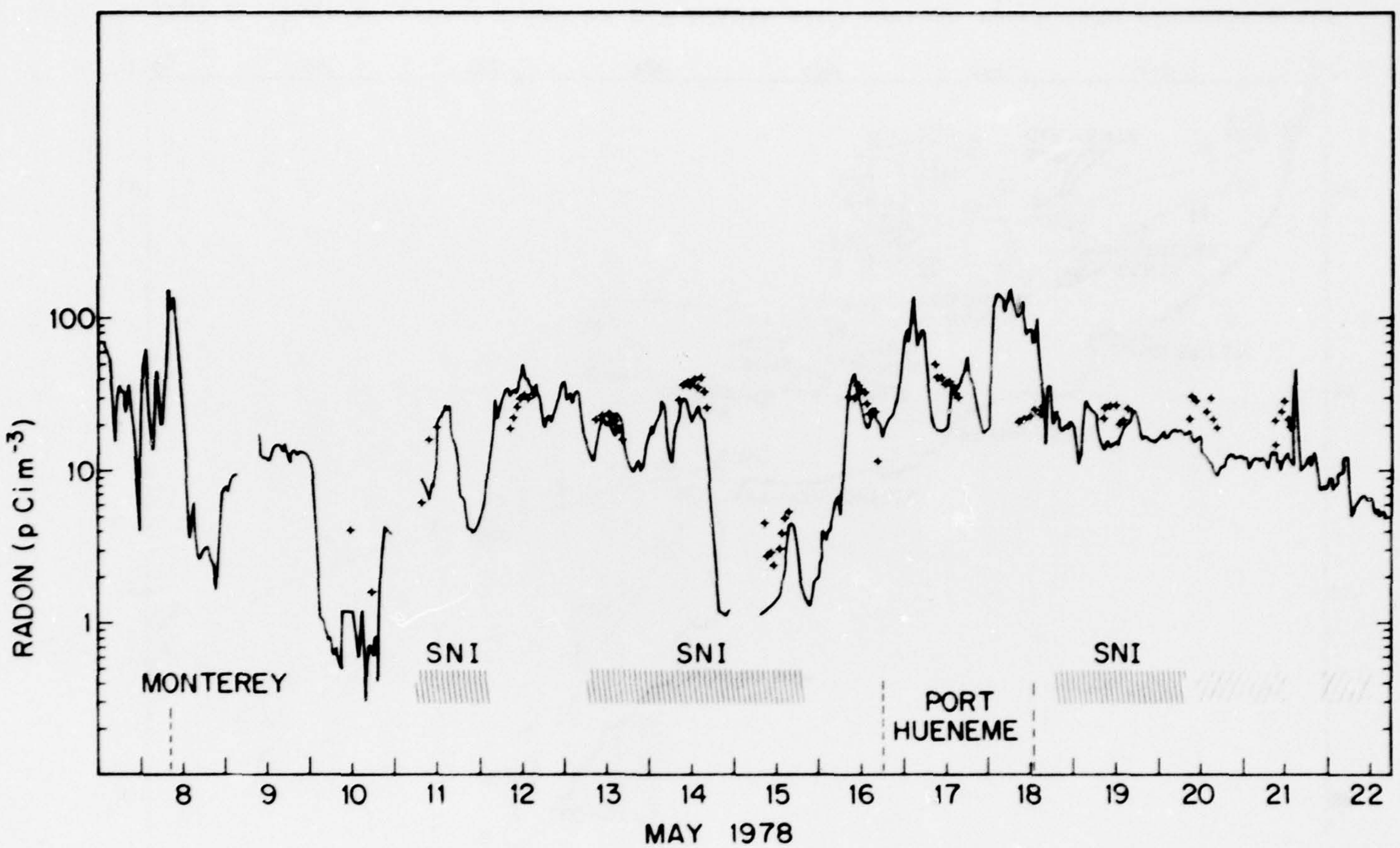

Fig. 1 - ^{222}Rn concentrations. Solid line connects individual ARC data points. Crosses represent individual samples collected at San Nicolas Island. Close hatching indicates when the R/V ACANIA was close to the island and broad hatching indicates when ship was upwind of the island.

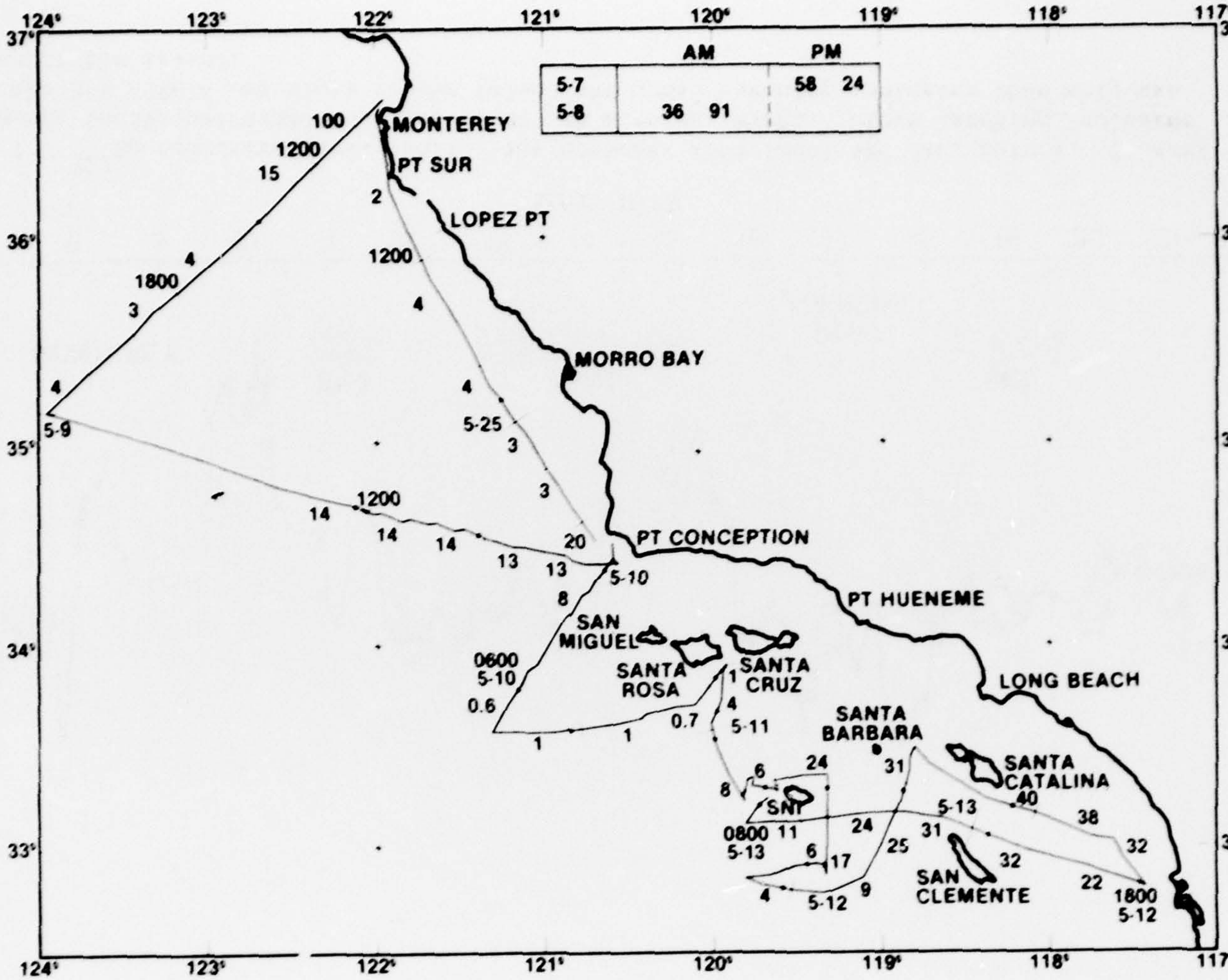

Fig. 2 - Part of cruise track of R/V ACANIA with average radon (ARC picocuries per cubic meter) over three hour intervals. Data in block is in-port radon averaged over six hour intervals.

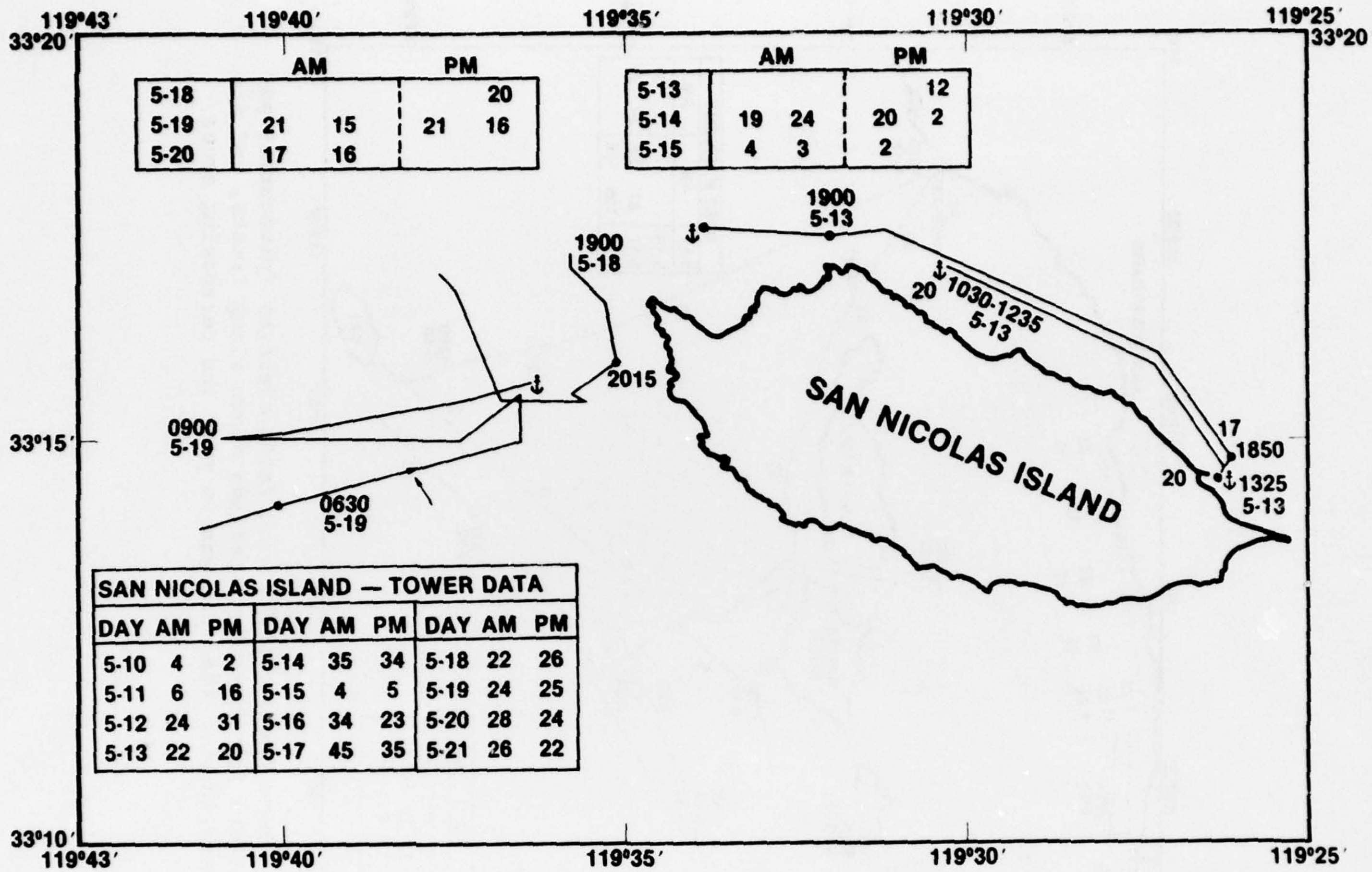

Fig. 3 - Some ship tracks near San Nicolas Island. Upper data blocks are average shipboard data averaged over six hour intervals. Lower block is average of island data in the mornings and afternoons.

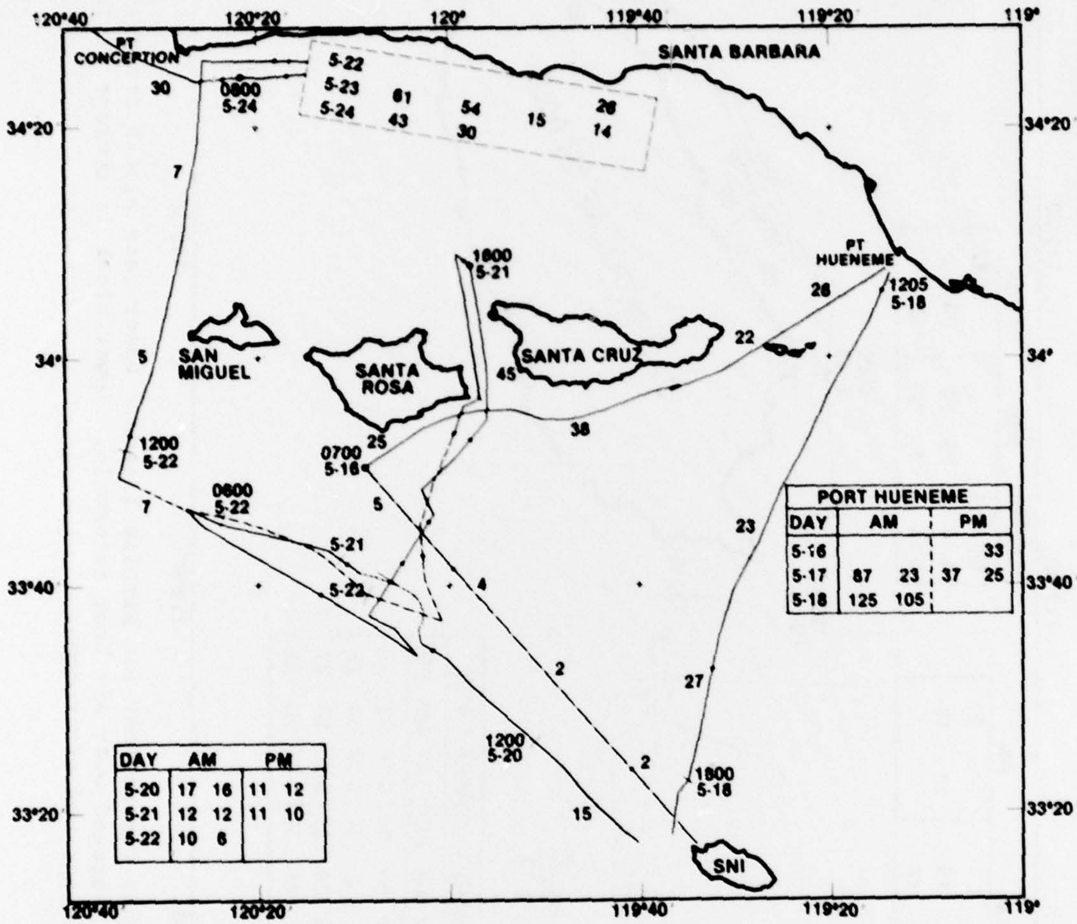

Fig. 4 - More cruise tracks with radon averages (picocuries per cubic meter) for three hour periods shown along tracks, and six hour averages when the ship was in port and recrossing areas

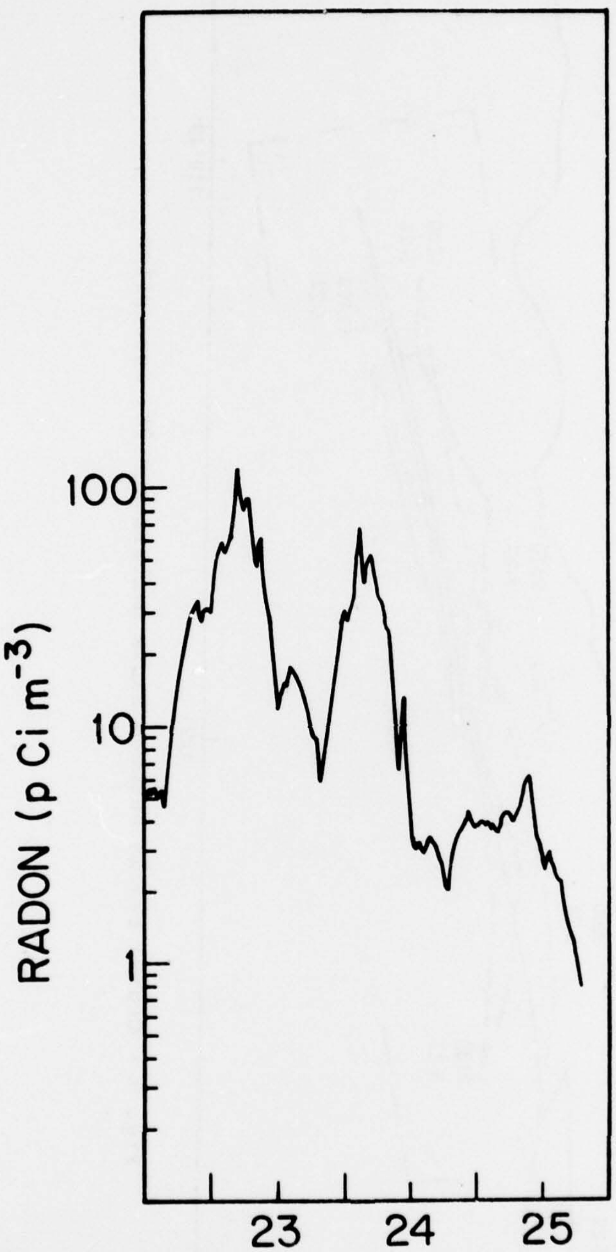

Fig. 5 - ^{222}Radon concentrations while the R/V ACANIA was in the Santa Barbara Channel and during transity to Monterey

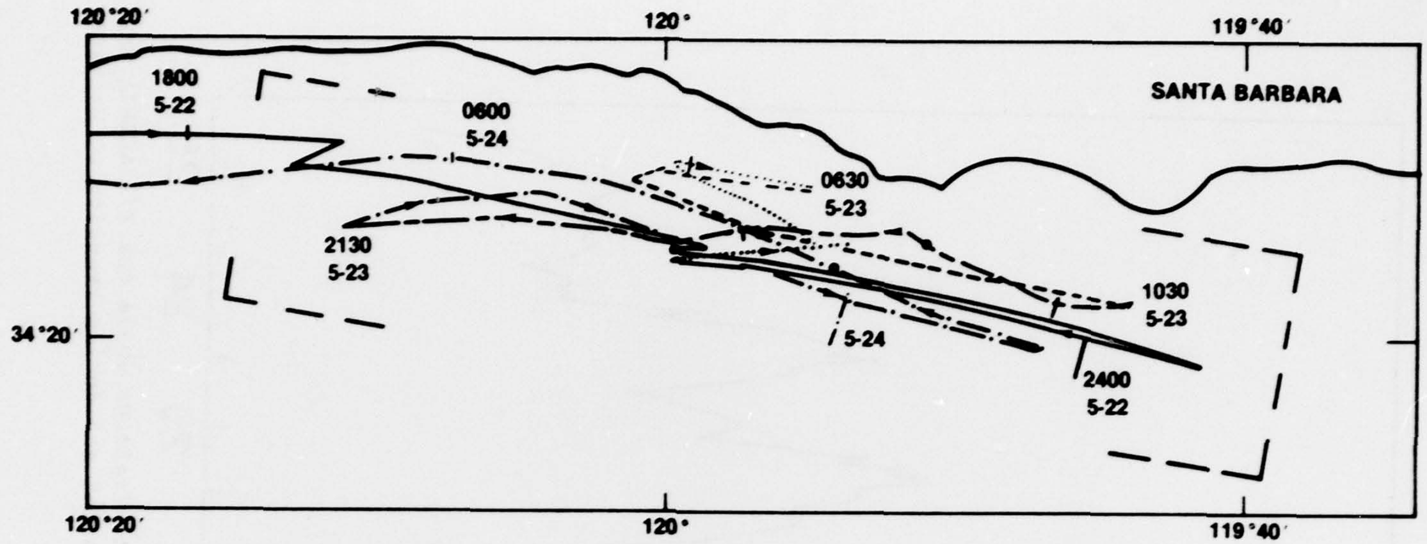

Fig. 6 - Cruise tracks between Santa Barbara and Pt. Conception

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