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UNIVERSITY OF Miami

Dr. Tom Kinder
Office of Naval Research
800 N. Quincy Street
Arlington VA. 22217

October 19, 1994

Dear Tom

Enclosed is the final report for Grant No. N00014-92-J-1788, "Tracers of Columbia River Input into the meandering California Current Coastal flow". The results are along the lines that I expected. I hope in the coming year to publish a short paper on this. Thanks for your support.

Sincerely,

Dr. David Kadko

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FINAL REPORT

TITLE:
Tracers of Columbia River Input into the meandering California Current Coastal flow.

GRANT No. N00014-92-J-1788

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per Ltr

BUDGET
FY 1993: $31,685

A-1

LONG-TERM OBJECTIVES:

The long-term objective of the PI is to utilize radioisotopic distributions in the ocean for the purpose of unraveling oceanic circulation patterns and investigating the rates of mixing processes. Specific problems of current interest include the formation and fate of the cold filaments off the N. California Coast, and ocean ventilation and subduction processes. Because these isotopes have half-lives ranging from days to years, it is possible to study processes which encompass a great variety of temporal and spatial scales.

OBJECTIVES:

One of the findings of the California Coastal Transition Zone (CTZ) project was that the cold filaments observed through satellite imagery apparently are part of a meandering jet within the California Current System (CCS). It has been suggested in fact, that a significant part of the CCS flow is encompassed within this meandering system.

The jet carries a surface salinity minimum and separates open ocean water of low salinity and nitrate on its offshore side from high salinity and nitrate on its inshore side. The cold, salty and nutrient rich water is of upwelled origin, but the origin of the fresh water in the salinity minimum has not been established. In all likelihood, it must come from upstream of the Pt. Arena filaments because low salinity water has been traced in the meandering flow to north of Cape Blanco. The working hypothesis of this work is that the source of this water is Columbia River outflow, although no tracers have been available (other than salinity) to demonstrate this.

APPROACH

In analyzing my CTZ data and reviewing the literature, I have found that Ra-226 can be a fairly straightforward tracer to show that the Columbia outflow is a major contributor to the surface water of the jet. I first noted that the Ra-226/salinity or Ra-226/nitrate ratio of the jet surface was extremely high (Fig 1B). This signature was quite unusual for ocean water and at first I was at a loss to explain it. Li et al. (1977) found that in the salinity gradient of the Hudson Estuary substantial Ra-226 was released from particles (presumably by an ion-exchange process). This results in an excess of Ra-226 relative to the conservative Ra vs. salinity mixing plot for the Hudson system. It is reasonable to believe that the same process is occurring in the salinity gradient near the mouth of the Columbia River. It follows then that the Ra-226 released in the low salinity water by this process is that which is observed within the coastal meandering flow. Measurement of the ocean and river component compositions will allow an estimate of the contribution of Columbia River input into the meandering flow.

TASKS COMPLETED

My proposed work entailed sampling the Ra-226/salinity ratio across the salinity gradient of the Columbia River. Samples from below the Bonneville Dam (0 ppt salinity) to beyond the river mouth (>32ppt) were collected from several depths and filtered. At this time, approximately 80% of the samples have been analyzed for radium. Figure 1A shows that as expected, the outflow water from the Columbia system has much higher ^{226}Ra/S ratios than the subsurface water of the filament. The significant point is that the high ^{226}Ra/S water of the filament surface (the ellipse in both Figs 1A, 1B) falls between these extremes, indicating that it is a mixture of these two water types. The Columbia River outflow must contribute a significant portion of the surface filament water; it is difficult to conceive of another source of high ^{226}Ra/S water.

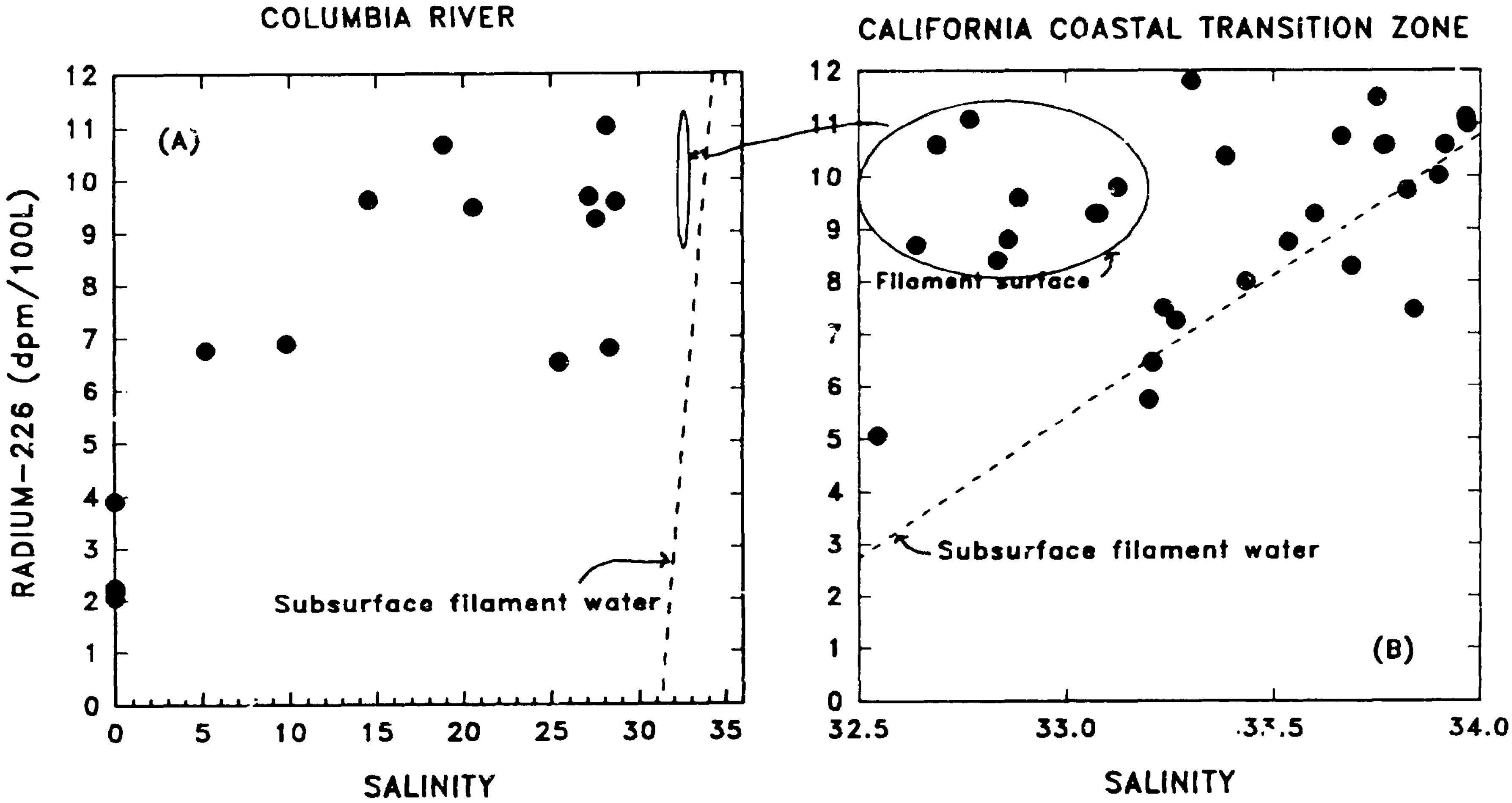

Figure 1. A) Ra-226 plotted against salinity for the Columbia River Estuary. Indicated are the trend for the subsurface filament water in Figure 1B, and the high Ra-226, low salinity water of the filament surface, also shown in Figure 1B. B) Ra-226 plotted against salinity for samples collected in the California Coastal Transition Zone. Note the distinction between water of the filament surface, and subsurface.