SEARCH FOR HYDROTHERMAL DEPOSITS ON JUAN DE FUCA AND EXPLORER RIDGES NORTHEAST PACIFIC OCEAN

By R. L. Chase*, J. W. Murray*, E. V. Grill†, Guy Beland*, and Ray Cook*

INTRODUCTION

A three-week cruise to the crestal areas of Juan de Fuca and Explorer Ridges in the northeastern Pacific Ocean (June 16 to July 8, 1977) aboard the Canadian Forces Auxiliary Vessel *Endeavour* resulted in the mapping of bathymetry of two areas of 2 900 square kilometres and 2 100 square kilometres respectively, and the raising of 66 sediment cores, two dredge hauls, and 23 hydrographic casts. The areas surveyed are shown on Figure 21. The purpose was to investigate the effect of hydrothermal processes in young volcanic oceanic crust on the heavy-metal content of overlying oceanic sediments.

Forty-three bathymetric profiles were recorded, totalling 2 053 kilometres in length. A sound frequency of 3.5 kilohertz was used, in order to reveal fine structure in thin discontinuous sedimentary sequences overlying the young volcanic and tectonic features at spreading ridges. Profiles were spaced about 5 kilometres apart in each area. Navigation, by Loran A, gave position with accuracy of 1 mile.

Cores were taken with gravity corers (lowered on wires) and with Benthos Boomerang corers (independent pop-up). The top of each core was sampled immediately after it was brought aboard, and monitored for copper, lead, and zinc by a dithizone test (Bloom, 1955).

The near-bottom water column was sampled by Niskin samplers equipped with reversing thermometers at many core sites in order to detect anomalous temperature or chemistry which might be caused by emission of hot brines from fissures near the ridge crest. Lister (1974) developed the theory of heat loss from hydrothermal circulation through fissures to explain anomalously low heat flow on the western flank of Juan de Fuca ridge. The east flank, blanketed with sediment from Cascadia plain, has a heat flow distribution closer to the theoretical.

The cores recovered in 1977 all contained olive-grey mud, in places graded, and, in many cores, overlain by red-brown mud, up to 10 centimetres thick. The dithizone test for copper, lead, and zinc suggested that manganese and iron oxides in the red-brown mud are variably enriched in copper, lead, and zinc. The first area surveyed (area 1 on Fig. 21), at the northern end of Explorer Ridge, includes two short ridge segments with well-defined rift valleys bounded by transform faults. The topography protected the valleys from inundation by Pleistocene turbidity currents. Enriched red-brown mud occurs within and on the sides of the valleys, along the transform faults, and away from the valleys on the northwest flank of the ridge. The second area, near the northern end of Juan de Fuca Ridge (area 2 on Fig. 21), includes several valleys and intervening horsts parallel to the ridge. The western valley is the present locus of spreading (McManus, *et al.*, 1972; Barr and Chase, 1974; Davis and Lister, 1977). In contrast to the first area, the second area was

*Institute of Oceanography and Department of Geological Sciences, University of British Columbia.
†Institute of Oceanography, University of British Columbia.

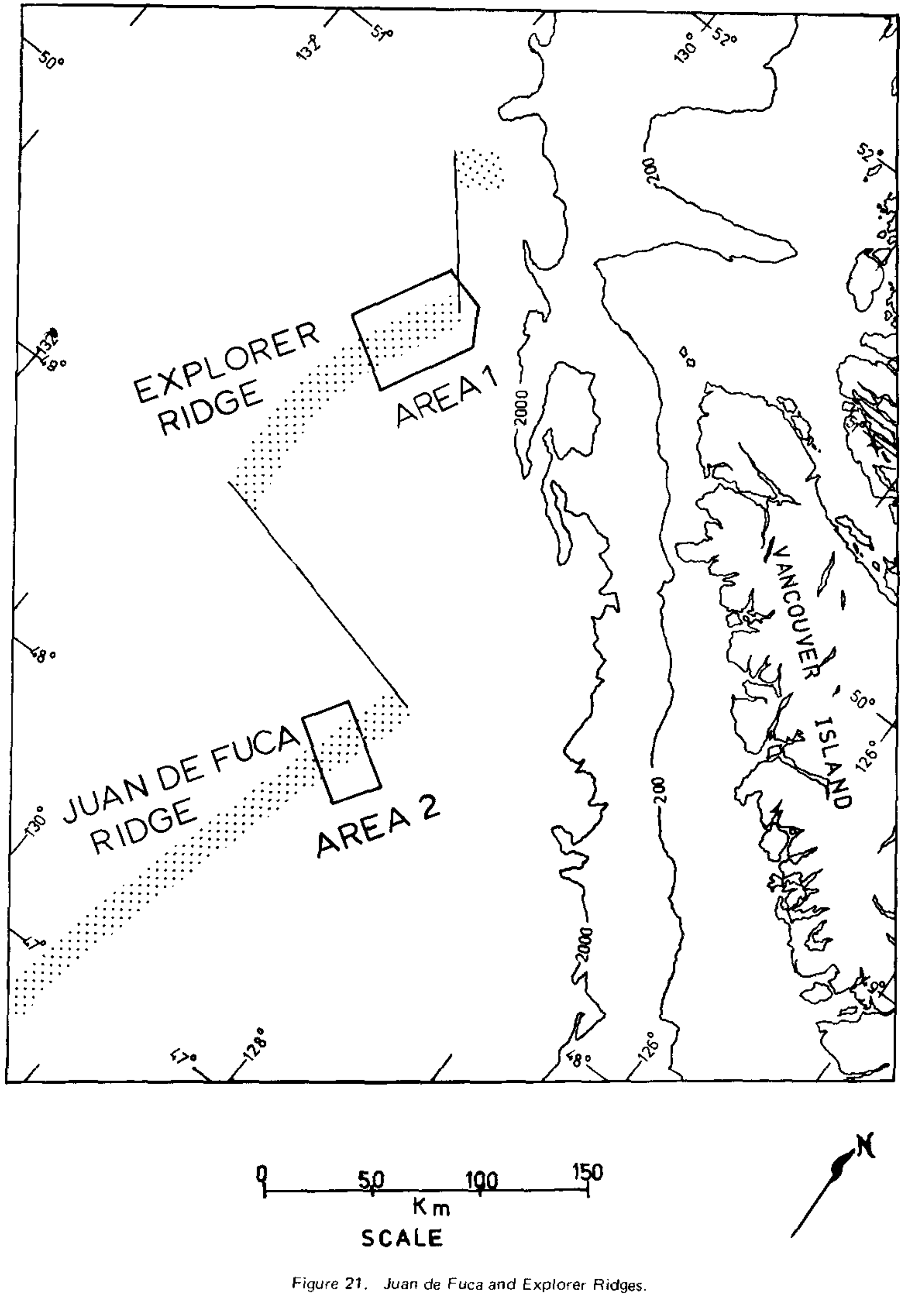

Figure 21. Juan de Fuca and Explorer Ridges.

flooded by turbidites during the Pleisotcene. Enriched red-brown mud several centimetres thick overlies turbidites and, in places, basalt, fragments of which were recovered in some cores. Outside the area, eastward toward the continental margin, upon the distal end of Nitinat deep-sea fan, however, the red muds were not encountered in cores. Several cores raised on a single traverse west of area 1, on the northwestern slope of Explorer Ridge, also showed enrichment. Thus it appears that enrichment is present at the active ridge crests but also occurs on the western flank of the ridges. One hypothesis to explain the existence of the contrasting red-brown and olive-grey layers is that the latter are Pleistocene, and the former Holocene, their difference being caused by differing sedimentational regimes, a result of the post-Pleistocene flooding of the continental shelf. Another hypothesis has the red-brown layer as the normal product of upward diffusion of porewater in deep-sea muds, with oxidation and precipitation of iron and manganese near the sediment-water interface. Selk (M.Sc. dissertation, Oregon State University, 1977) concluded that hydrothermal activity led to the formation of manganese-rich sediments in a trough in the active Blanco Fracture Zone south of the areas investigated. Metalliferous sediments occur along thousands of kilometres of crestal areas of spreading rises (Bonatti, 1975; Heath and Dymond, 1977). Cronan (1976) found metalliferous sediments widely distributed at the volcanic-sediment interface on the western flank of the East Pacific Rise. Hydrothermal activity has been observed directly on the Galapogos and Mid-Atlantic Ridge (Von Herzen, *et al.,* 1977; Rona, 1977).

Since the cruise, cores have been split, logged, photographed, and samples taken for heavy metal analysis. The cores and data from the cruise will form the basis of M.Sc. projects for R. Cook and G. Beland.

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