1. INTRODUCTION[1]

Shipboard Scientific Party[2]

BACKGROUND

Leg 139 of the Ocean Drilling Program (ODP) was the first of two proposed legs designed to investigate hydrothermal processes and products at seafloor spreading centers that are covered with sediment. Sedimented spreading centers provide ideal targets for drilling because a regionally continuous, relatively impermeable sediment cover over zero-age crust limits the recharge and discharge of hydrothermal fluids, and thermally insulates the underlying crust. This creates a thermal regime in which high formation temperatures can occur at relatively shallow levels in the crust. Where discharge of fluid does occur, very large hydrothermal sulfide deposits can be produced. The sediment may preserve a relatively continuous stratigraphic record of magmatic, tectonic, and thermal events, providing clues to the spatial and temporal variability of these processes. The sediment also stabilizes the drill string and allows holes to be "spudded" without the operational expense of a complicated seafloor guide base.

Twenty-two holes were drilled during Leg 139 at four sites located in Middle Valley, an axial rift valley of the northern Juan de Fuca Ridge (Fig. 1), which in places is filled with over 2 km of hemipelagic and turbidite sediments that have been supplied during the late Pleistocene from the nearby continental margin. The primary objective of this leg was to characterize the hydrothermal circulation in the rift on a regional scale; detailed drilling in areas of hydrothermal discharge and mineralization is proposed for a second leg. Because of the difficult drilling conditions anticipated in hot and highly fractured crust, the program planned for this first leg relied primarily on proven technologies, both for drilling and for downhole measurements. Proposed drilling during future legs, which will focus on the mineral deposits in this environment and on deeper crustal penetration, may rely on the additional capabilities of new tools such as the diamond coring system being developed by the ODP.

MIDDLE VALLEY DRILLING SITES

The four sites drilled during Leg 139 (Figs. 2 and 3) are in four distinct hydrologic environments within the Middle Valley rift as defined by seismic reflection profiles, heat flow data, and other geophysical and geological information discussed in various chapters in this volume. Holes at Site 855 penetrated a zone of fluid recharge along the normal-fault scarp that bounds the valley to the east. Drilling at Site 856 sampled a large polymetallic sulfide deposit created by hydrothermal fluid discharge that is no longer active. Site 857 was drilled into a hydrothermal "reservoir" zone where high-temperature fluids were suspected to reside in the upper igneous crust beneath a complete sediment seal. Holes at Site 858 were located in and immediately adjacent to a hydrothermal vent field. The holes nearest the center of the field, including the hole chosen for reentry, penetrate an active upflow zone, where hydrothermal fluids ascend through the locally attenuated section of sediment above a buried basement edifice and vent at the seafloor. Hydrologic seals, instrumented to monitor formation temperatures and pressures for up to two years, were installed at the latter two of these sites, in reentry Holes 857D and 858G.

Despite the technically challenging nature of this program, the leg was extremely successful. Through the coring, downhole measurements, and long-term observatory experiments, major advances have been and will be made toward understanding numerous fundamental aspects of seafloor spreading in sedimented environments. These include the chemistry and physics of hydrothermal circulation; crustal genesis, structure, and alteration; hydrothermal mineral deposition;

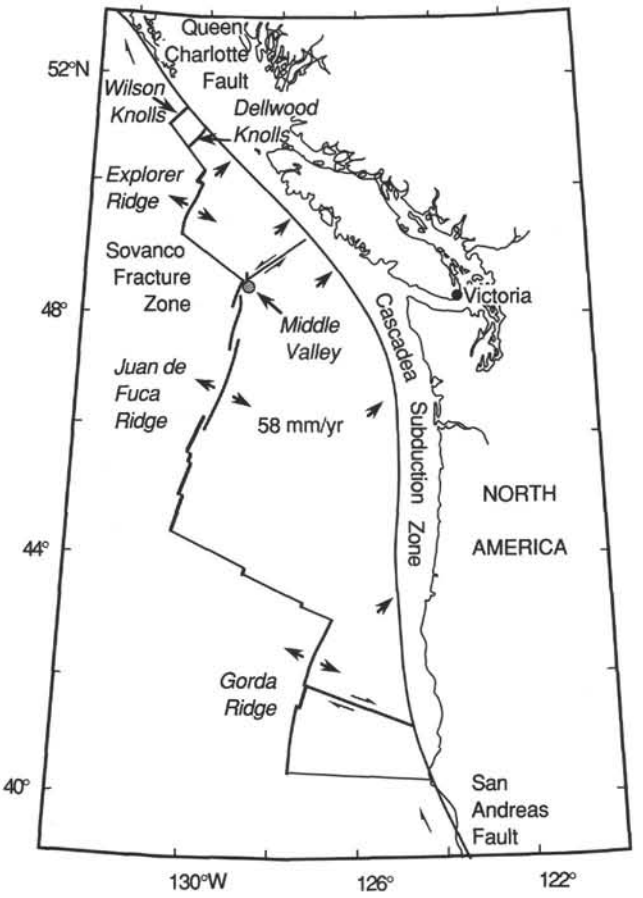

Figure 1. Location map showing the tectonic setting of the northern Juan de Fuca Ridge and the sedimented Middle Valley rift. Arrows indicate plate movement.

[1] Davis, E. E., Mottl, M. J., Fisher, A. T., et al., 1992. *Proc. ODP, Init. Repts.*, 139: College Station, TX (Ocean Drilling Program).

[2] Shipboard Scientific Party is as given in the list of participants preceding the contents.

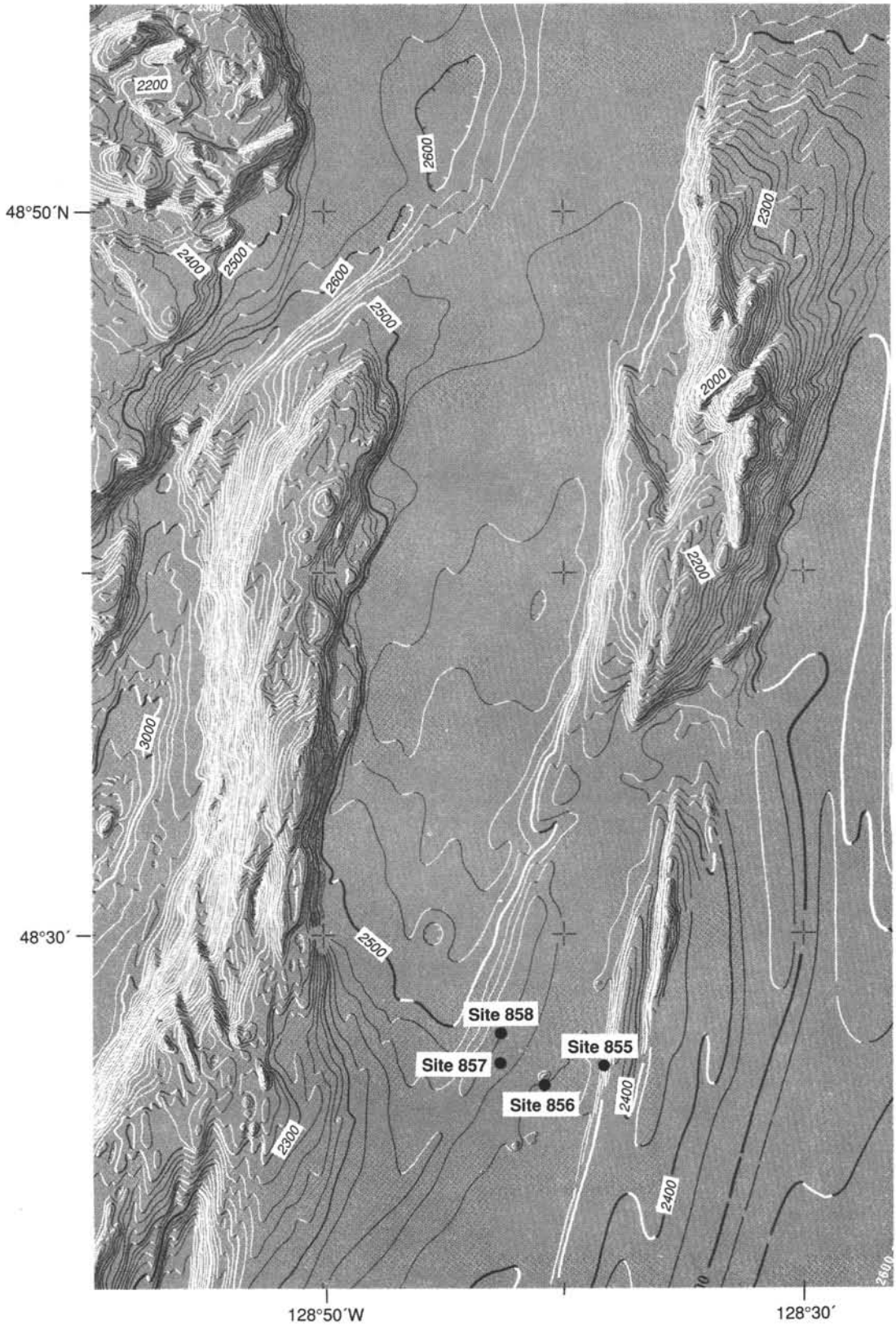

Figure 2. Bathymetry of the northern Juan de Fuca Ridge, shown as contours drawn at 20-m intervals and "illuminated" from the west. Site locations for Leg 139 are indicated.

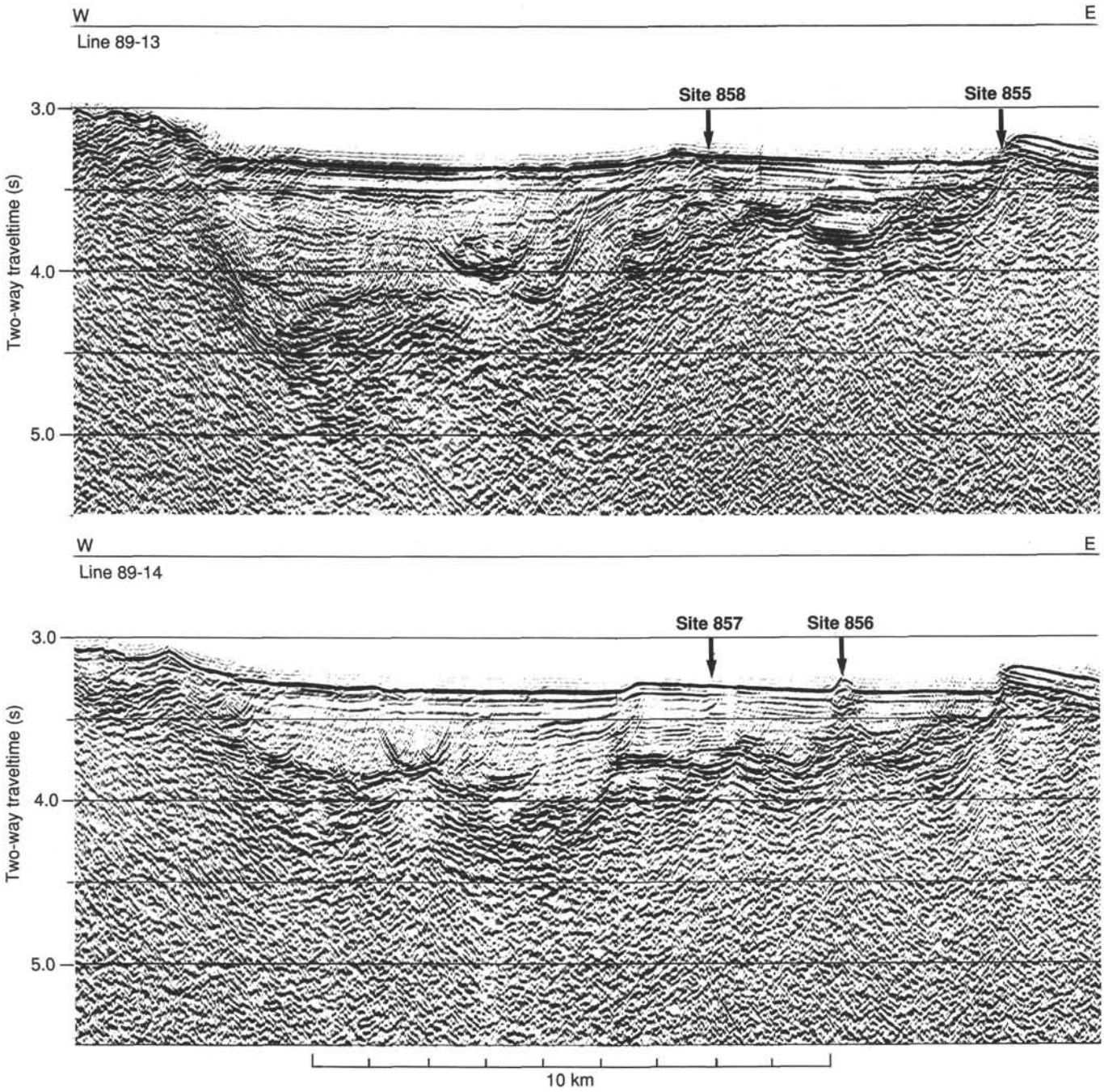

Figure 3. Multichannel seismic reflection profiles crossing southern Middle Valley and the Leg 139 drilling sites. Tracklines and larger scale plots can be found in the back-pocket foldout of this volume.

sediment diagenesis and alteration; hydrocarbon maturation and migration; sediment deposition in an environment of extremely high depositional rates; and the biostratigraphy of the latest Pleistocene in this part of the northeast Pacific. Also important is the new-found knowledge that the robust drilling and coring technology of the Ocean Drilling Program can be applied successfully in hot, hydrothermally active environments; that with careful use of post-drilling fluid circulation, standard logging tools can be safely deployed; and that numerous "temperature-hardened" tools, some borrowed and some developed for this program, including a modified water-sampling temperature probe and a new pressure core sampler, can be relied upon for routine service. We can look forward with confidence to extending this work during a future leg.

Ms 139A-101