active K^{40}. Although the same radionuclides were reported in core samples from this general area (6), the *in situ* spectra are clearly superior. The large "sample size" assures an increased counting rate that more than compensates for the loss of detail resulting from the effects of the water on the γ-ray photons.

Comparison of a spectrum of coarse sand and gravel, in 30 m of water 1.6 km off Newport, Oregon (Fig. 2*b*), shows no radionuclides resulting from operations at the Hanford laboratories. The plume of the Columbia River does not normally move into this area, although marine animals taken here contain Zn^{65} (7). Most deposits of silts and clays in the northeast Pacific Ocean, which might have larger amounts of artificial radioactivity than sands and gravels, are beyond the present range of our probe. Range is restricted by the 54-m cable used in these tests, but Riel (8) has shown that longer cable lengths are feasible. The probe housing was designed for and tested at much greater pressures, and the only modifications required are in the cable length and associated electronics. These modifications are in progress and should let us work down to about 400 m.

Our interest lies in the relationship of the radioactivity of animals to that of their environment. Analysis techniques for animals are relatively simple, since the specific activity of the samples can be increased by ashing, with the ash counted in the well of a NaI(Tl) crystal (12.5 by 12.5 cm) in the laboratory. There is no easy comparable method of concentrating the radioactivity in sediment samples. The difficulties inherent in the collection and subsequent radioanalysis of sediments seem to make methods of probing *in situ* worthy of further effort.

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References and Notes

1. The actual depth to which the probe "sees" depends on both the energy of the γ-ray emitters and the density of the matrix material. Therefore, the effective size of the sample would be less for Cr^{51} (0.32 Mev) than for K^{40} (1.46 Mev).
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9. Support from U.S. AEC contract AT(45-1)1750 and PHS training grant 1T1-WP-59-01. The data are a result of thesis research for a master's degree from Oregon State University. We thank R. S. Mesecar and W. E. Bales for design of the electronic circuitry and suggestions for waterproofing the probe.

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Kink-Bands: Shock Deformation of Biotite Resulting from a Nuclear Explosion

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Abstract. *Microscopic examination of granodiorite samples from the shock region around a nuclear explosion reveals sharply folded lens-shaped zones (kink-bands) in the mineral biotite. Fifty percent of these zones are oriented approximately 90° to the direction of shock-wave propagation, but other zones are symmetrically concentrated at shear angles of 50° and 70° to the direction of shock-wave propagation.*

In 1962, a 5.2-kiloton nuclear device was detonated in the granodiorite of the Climax stock, Nevada Test Site (Hardhat event). Deformation of biotite in the form of sharply folded lens-shaped zones (kink-bands) was observed by microscopic examination of samples affected by the shot. As a basis for defining explosion-produced effects, samples taken prior to the detonation were examined and compared with those taken after the shot (postshot samples). The locations in the reentry tunnel where the postshot samplings were made and the drill core are shown in Fig. 1.

All thin sections cut from the six samples in the reentry tunnel were oriented by having the planar dimension of the section parallel to a radius drawn from the shot point. Although the orientation for most sections cut from the postshot drill core was not known (because of rotation of the sample in the core barrel during drilling), sections from the four samples C_8, C_9, C_{10}, and C_{11} could be oriented parallel to a radius from the shot point.

Of the ten oriented postshot sections only the eight within the shock zone (1) displayed kink-bands (Fig. 1). These eight were examined for preferred directions of kink-bands. Of the 110 observed kink-bands in the ori[...] sections, 50 percent were oriented [...] the long axis of the lens at 90° [...] to a radius drawn from the shot p[...] (Fig. 2*A*). Approximately 12 pe[...] and 10 percent were oriented with [...] long axis of lens at 50° ± 1° [...] 70° ± 1°, respectively, from the r[...] (Fig. 2*B*).

Because only the eight oriented [...]ples within the shock zone showed [...] bands, the explosion-produced [...] wave was probably the (compre[...] stress which formed the kink-bands [...] shock wave passes spherically out[...] from the shot point so that its [...] moves along radii drawn from the [...] point. The kink-band orientation [...] thus be related to the direction of [...] propagation. The unoriented se[...] can be oriented by assuming th[...] greatest percentage of kink-ban[...] normal to the direction of shock-[...] propagation.

A total of 701 kink-bands [...] oriented and unoriented sections [...] counted. Their frequencies and o[...]tions with respect to the shock [...] are shown on Fig. 3. The relative [...]quencies of the principal orien[...] for the unoriented sections ar[...] same as those from the oriented [...]tions. This suggests that the [...] for deducing the direction of [...] wave propagation in unoriented [...]tions is not greatly in error.

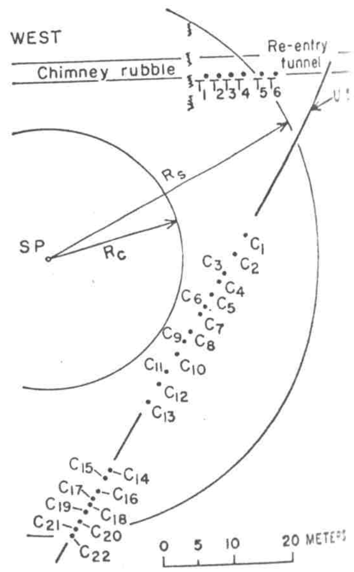

Fig. 1. Cross-sectional diagram [...] vicinity of the Hardhat event [...] the reentry tunnel, postshot [...] (U15G), shock-zone radius (R_s[...]) radius (R_c), shot point (SP), a[...] locations in the tunnel ($T_1 \cdots$[...]) drill hole ($C_1 \cdots C_{22}$).