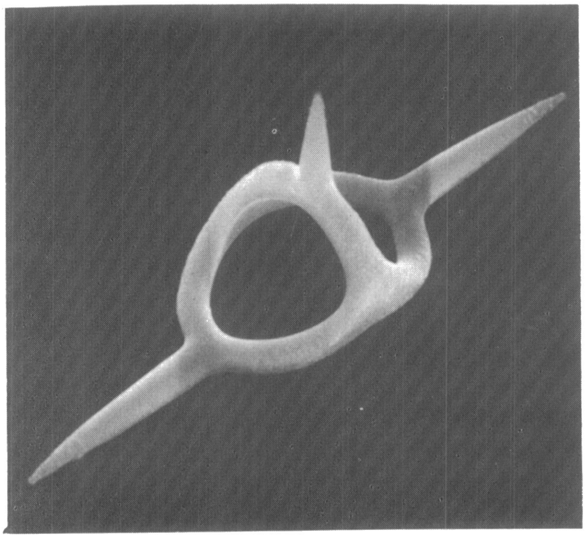

Naviculopsis. X 1500. Eocene silicoflagellate with one long spine on its central bridge. Scanning electron photograph made by Jeolco, Burlingame, California, and the California Academy of Sciences.

be deposited in the Department of Geology Type Collection of the California Academy of Sciences. A paper describing the fauna of silicoflagellates in this sample is in preparation.

Acknowledgements. The help of G Dallas Hanna and Mort D. Turner is gratefully acknowledged. This study was supported in part by National Science Foundation grant GA–1173.

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Grain Surface Features in *Eltanin* Cores and Antarctic Glaciation

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Eltanin deep-sea cores from the southern oceans have been evaluated throughout their length with respect to the mineralogy of the sand and clay-size material. In addition, the surface features of the quartz grains and other selected minerals have been examined optically and by electron microscope for evidence of glacial transport, environmental marks, and/or diagenetic alterations.

Krinsley and Newman (1965) suggested that the surface features of quartz grains are of value in recognizing sediments of glacial origin. Krinsley and Takahashi (1962a, b), Krinsley and Donahue (1968), and Krinsley and Margolis (1969) have postulated that grain surface features are not only diagnostic of a glacial origin of sediments, but of other environmental origins as well. The majority of this work has been accomplished utilizing the electron transmission scope, and currently the Scanning Electron Microscope (SEM). Recently, an optical technique employing interference microscopy (Warnke *and* Gram, 1968, in press) for examining grain surface replicas has been investigated.

An even simpler optical technique has now been developed for direct examination of grain surfaces using reflected dark-field illumination with the Leitz Ortholux Ultropak system. This method has been compared with electron microscopy with favorable results. The latest optical method has the advantage of enabling rapid evaluation of many grains without the necessity of plating or replica-making. A depth of field problem exists with the optical methods, particularly at higher magnifications, and some of the more minute features may, therefore, go unobserved. However, the speed of the optical techniques permits a large number of observations to be made and, therefore, increases the statistical reliability. This advantage compensates for the depth of field problem to a large degree. During the present study, no features of significance were observed electronically that were not visible using optical methods.

In an effort to more fully establish the accuracy of the surface-feature environmental criteria established by the aforementioned workers, and to validate the optical technique developed by the present author, quartz grains from numerous environments were examined. These grains were obtained from icebergs off the Antarctic Peninsula; Alaskan glaciers and their outwash plains (Slatt *and* Hoskin, 1968); Florida, California, and New York beaches; and Florida, California, and Texas sand dunes. Some Florida river samples were also examined. The results of this effort have, in general, supported the work of Krinsley and his coworkers. Consequently, the use of optically identifiable grain surface features as indicators of environmental origin is believed to be a valid technique.

Fig. 1 is a SEM photograph of a quartz grain from the 6–11 cm interval of *Eltanin* core 11–13. The photo shows the high relief, parallel steps, and breakage pattern attributed to glacier action. Fig. 2 is a reflected-light photomicrograph of a quartz grain from the same core showing similar features; the grain is from the 1,695–1,700 cm interval. Preliminary results from this study indicate that, in general, at least one-third of the sand-size quartz present throughout the core lengths show surface features resulting from glacier activity. The majority of the cores examined extend into the Gauss Paleomagnetic Epoch, four extend into the Gilbert, and one through the Gilbert. The quantity of quartz present in these cores showing direct evidence of glacial transport supports Goodell and others (1968) in their hypothesis that widespread glaciation of the Antarctic Continent was in progress at least 5 m.y. ago.

A core believed to be of Eocene age (Geitzenauer, verbal communication) also contained some ice-rafted quartz throughout its length, although the percentage of such grains was considerably lower than in the other cores examined. The majority of grains in this core showed a combination of glacially derived features and diagenetic or chemical features, or were non-diagnostic. However, the presence of some grains showing evidence of glacier activity supports to a degree the evidence of Eocene glaciation of the Antarctic found in another core by Geitzenauer and others (1968).

Acknowledgements. This research was supported by the National Science Foundation under grant GA–4001 to Dr. H. G. Goodell. Drs. Biedler and Gradziedi, Florida State University, permitted the use of the SEM, and Mr. R. Parker took the SEM photograph. Grains examined during this study, other than those from *Eltanin* cores, were provided by Messrs. D A. Warnke, R. M. Slatt, E. Hopkins, F. Stapor, and the author.

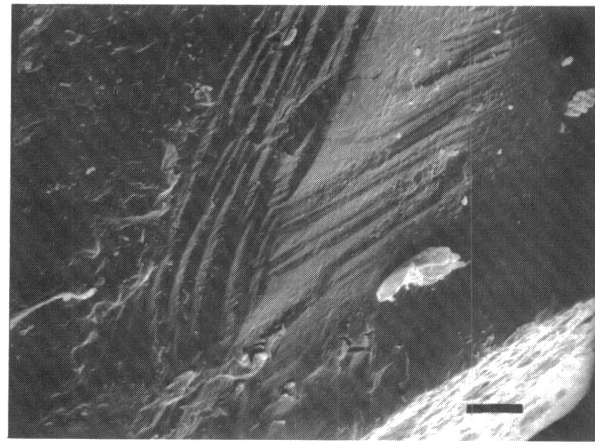

Figure 1. SEM photograph of quartz-grain surface showing features resulting from glacier or ice transport. Grain from *Eltanin* Core 11–13, 6–11 cm interval. Scale bar equals 10 microns.

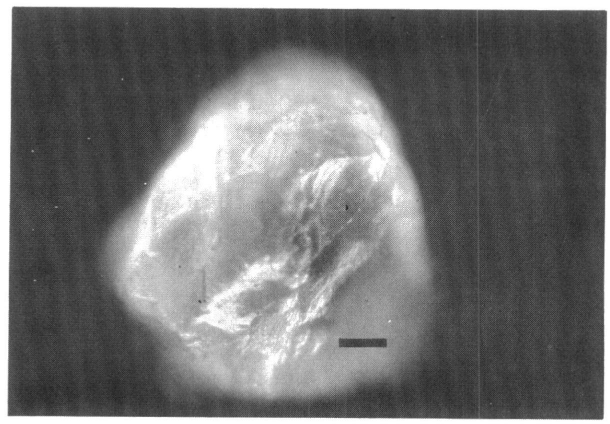

Figure 2. Light micrograph of quartz-grain surface showing features resulting from glacier or ice transport. Grain from *Eltanin* Core 11–13, 1,695–1,700 cm interval. Scale bar equals 10 microns.

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