Rains basin. The ages observed here and those from previous missions do not provide evidence for extensive volcanism in the last 3×10^9 years of lunar history.

Glasses on the moon can form either by impact or by volcanic processes. The age indicates that the glass of the orange soil formed close in time to the volcanic activity in the Sea of Serenity, $3.75 \pm 0.05 \times 10^9$ years ago. The orange soil certainly was not formed by a recent fumarole. The young exposure age, $32 \pm 4 \times 10^6$ years, found for the glass of the orange soil is in agreement with its fresh appearance on the lunar surface. Since the orange soil was found around Shorty Crater, it may have been exposed by the formation of Shorty Crater.

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Late Cretaceous (Maestrichtian?) Silicoflagellates from the Alpha Cordillera of the Arctic Ocean

Abstract. *A Late Cretaceous (probably Maestrichtian) silicoflagellate assemblage has been recovered for the first time from the middle section of a core taken from the Alpha Cordillera in the central Arctic Ocean. The finding of* Globigerina pachyderma *in the top and very rarely in the bottom part of the core suggests a faulting or slumping process in the area.*

Significant progress has been made recently concerning the history of the Arctic Basin. Discussions of the paleoclimatology and the magnetic polarity of late Cenozoic deep-sea sediments have been based on sediment cores collected from Fletcher's Ice Island (T-3) (*1*). Furthermore, Karasik (*2*) estimated the age of the Eurasia Basin to be approximately 60 to 70 million years from geomagnetic polarity history; and the magnetic profile records and comparison with the North Atlantic led Vogt and Ostenso (*3*) to suggest that sea-floor spreading ceased along the Alpha Cordillera 40 million years ago. Spreading along this axis was active at least 60 million years ago, and initiation of spreading may have been as early as 220 million years ago. According to Pitman and Talwani (*4*), the Nansen Ridge has been the locus of all the Arctic Ocean spreading for the past 63 million years. All of these studies make it clear that, until now, the occurrence of pre-Pliocene deposits has not been confirmed.

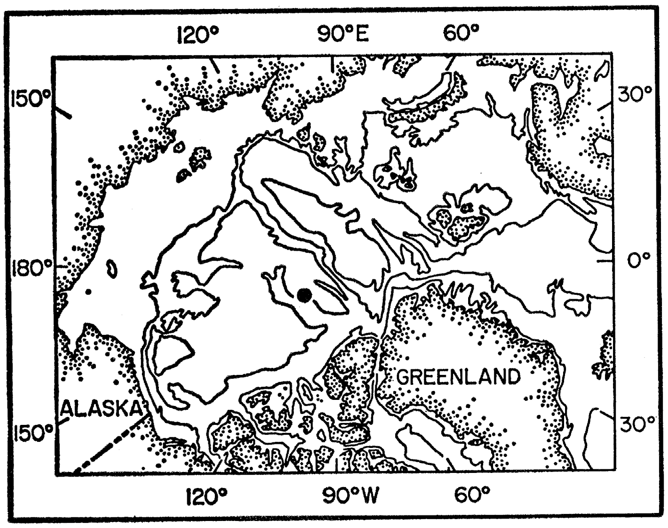

Fig. 1. Index map of the Arctic Ocean and the location of core 437 from Fletcher's Ice Island (T-3) (filled circle).

Core 437 was taken at 85°59.87′N and 129°58.76′W at a depth of 1584 m from Fletcher's Ice Island (T-3), on 2 September 1969 (Fig. 1). The core is 282 cm long. Lithologically, the upper 46 cm consists of "normal" Arctic gray-brown [2.5Y 5/4, according to Munsell's *Soil Color Chart* (*5*)] lutite. Below this is 172 cm of bright orange yellow (2.5Y 6/6) tuffaceous lutite. Bedding is very prominent in this sequence and makes an apparent angle of 45° to the horizontal. X-rays of the clay minerals in three samples from this interval showed approximately 40 percent illite, 20 percent chlorite, 10 to 20 percent kaolinite, and 5 to 30 percent montmorillonite. Underlying this unit is 64 cm of dark brown (5Y 3/2) lutite. Contacts may be unconformable.

Core sediments are divided into 15-cm segments and numbered consecutively upward. Paleomagnetic work at 5-cm intervals shows normal polarity throughout the core. Planktonic Foraminifera, *Globigerina pachyderma* (Ehrenberg) and fewer *G. quinqueloba* Natland, both cold-water species, are found in the upper and lower portions of the core. *Globigerina pachyderma* is present in the upper 46 cm (segments 19 through 17) and very rarely in the lower segments (6 and 1). A few specimens of *G. quinqueloba* are also identified in these segments.

Samples from the center of each segment were treated for examination of the silicoflagellate assemblage (*6*). Only the middle part of the core (segments 16 through 2) contained abundant silicoflagellates. The assemblage is rather monotonous, consisting of the following taxa (Fig. 2), discussed in order of decreasing abundance.

Vallacerta siderea, originally described by Schulz (*7*) from West Prussia, is the most dominant species; individuals have four to eight radial

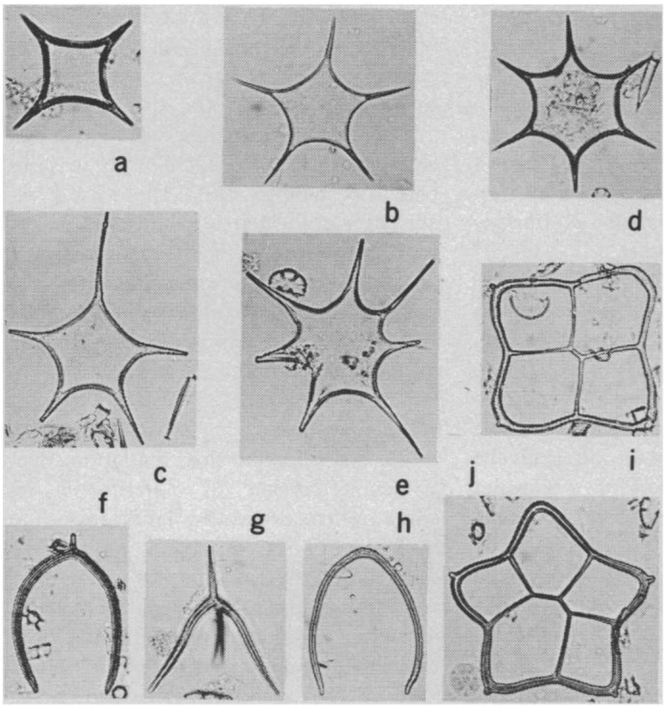

Fig. 2. Late Cretaceous (probably Maestrichtian) silicoflagellate species from T-3 core 437. (a–e) *Vallacerta siderea* (Schulz); (f) *Lyramula furcula* Hanna; (g) *Lyramula furcula* var. *minor* Deflandre; (h) *Lyramula simplex* Hanna; (i and j) *Dictyocha* sp. (magnification: × 210 except g, × 350).

spines and more than 95 percent are the five-spine forms. The range of this variation is illustrated in Fig. 2, a to e. The form with four spines has been referred to previously as *V. siderea* var. *quadrata* (*7*). In a previous article (*6*) and in works of other investigators (*8*), Schulz's species is regarded as a junior synonym of Hanna's *V. hortoni* from California (*9*). However, recent observations made with the scanning electron microscope reveal a definite difference in the surface microstructure between the two; accordingly, we believe that they are best regarded as separate taxa.

Lyramula furcula Hanna and *L. furcula* var. *minor* Deflandre are also found, ranging from abundant to common throughout the section. *Lyramula simplex* Hanna occurs rather rarely and only in segments 11 through 4, except that it is completely absent in segments 9 and 7.

A possible new species belonging to the genus *Dictyocha* occurs sporadically in segments 12, 8, 5, 4, and 2. This species is similar to *D. quadralta* from California (*9*) and also superficially resembles *Hannaites quadria* described from an Eocene South Atlantic core (*10*). It differs from them in that the corners are generally curved and not sharply pointed, and radial spines, if present, are very short. A specimen with a pentagonal basal body ring is considered as the intraspecific variation of the taxon. The middle part of the basal body ring is generally narrower (thinner) than that near the polygonal corners.

Although there is some difference in silicoflagellate composition (that is, the absence of other forms, such as *Corbisema geometrica* Hanna), the age of the silicoflagellate assemblage from the middle section of core 437 is assigned here as Late Cretaceous and possibly Maestrichtian, on the basis of comparison with the available previous records, including a Russian report (*11*). Abundant occurrences of *Vallacerta siderea* and *Lyramula* species and varieties are characteristic for such an age.

The lithological boundary between the upper two units agrees rather well with the finding of *Globigerina pachyderma* in the upper section and its absence coupled with an abundant occurrence of silicoflagellates in the middle section. The presence of *G. pachyderma* in the lower section may be explained by slumping. It is possible that the older Cenozoic and Cretaceous sediments (with a high bedding angle) were faulted or slumped sometime in the late Cenozoic onto late Cenozoic sediment with *G. pachyderma.* This sequence was then covered with a thin layer of sediment (with *G. pachyderma*). The few specimens of *G. pachyderma* found with the silicoflagellates were mixed in during this sequence of events.

The silicoflagellate assemblage from core 437 is significant because (i) to our knowledge this is the first recovery of any pre-Pliocene sediments from the Arctic Basin and (ii) at the same time, this is the first Cretaceous silicoflagellate record from deep-sea sediments from any part of the world. The previous attempt to identify deep-sea Cretaceous forms (*6*) in the samples returned from legs 1 to 3 of the Deep Sea Drilling Project (*12*) failed to recover such an assemblage.

Finally, further analyses on siliceous microfossils in the core sediments from this region may lead to the discovery of deposits of other ages and may provide additional biostratigraphic data on the microfossils as well as an interpretation of the geohistory of the Arctic Ocean.

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