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Pagodroma and Sirius Group stratigraphy and paleontology: Late Neogene Antarctic glacial sedimentation and a discussion of diatom provenance and paleoclimate

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Diatoms and silicoflagellates provide important proxy information and age control to guide interpretations regarding the timing, frequency and magnitude of paleoclimatic, paleoceanographic and cryospheric changes in the southern high latitudes. Glacigene strata of the terrestrial and marine Sirius Group in the Transantarctic Mountains and Pagodroma Group in the Prince Charles Mountains reveal a clear indication of the character of Neogene ice sheet conditions at several locations through time. The age and environmental conditions inferred for the Sirius Group based on diatoms has been a contentious point of discussions regarding Cenozoic ice sheet evolution. This paper presents a comparative review of numerous Sirius Group and Pagodroma Group deposits and then focuses on the Cloudmaker and Meyer Desert formations of the Sirius Group to establish a clear age assignment for the important paleontological specimens in the Meyer Desert Formation at Oliver Bluffs. The age of this formation and the terrestrial biota enclosed within these glacigene strata has been a topic of discussion and disagreement. The Pliocene age derived from the occurrence of reworked late Miocene and early Pliocene marine diatoms within the enclosing sediments has been challenged by the assertion that the diatoms are wind-borne surface contaminants. Reports of diatoms within Antarctic ice cores and on Antarctic surfaces in other areas of the TAM has provided this alternate explanation for the occurrence of the marine diatoms in the in the Meyer Desert Formation and other Sirius Group deposits. However, the diatom assemblage characteristics of the marine diatoms in the Meyer Desert Fm. and that of the eolian floras in ice cores and surface deposits are very different.

These assemblages cannot be derived from the same source or delivered to the Meyer Desert Formation by the same processes. This paper will contrast these different diatom assemblages by comparing their (1) ecology, (2) size, (3) age, (4) taxonomic composition, and (5) potential source areas as criteria to establish the unique features of the glacial-sourced and the eolian-sourced diatom assemblages. Erosion of the face of Oliver Bluffs by a late Pleistocene advance of Beardmore Glacier, as well as ongoing erosion by wind deflation and snow-melt dissection of the Bluffs, produced fresh exposures of the Meyer Desert Formation, which were sampled for diatom analyses. These strata that yielded the marine diatom assemblages were not exposed at the time of the Eltanin asteroid impact (2.1 Ma, late Pliocene). The sampled strata have been exposed only recently to surface processes. Thus, the suggestion that marine diatoms were incorporated onto the surface of the Meyer Desert Formation by fallout of impact ejecta at this location is untenable. However, if ejecta-sourced marine diatoms did blanket the ice sheet and TAM from the 2.1 Ma event, and these diatoms were subsequently picked-up by the ice that deposited the Meyer Desert Formation, they would indicate that the Meyer Desert Formation and enclosed biota was less than 2.1 million years old. Establishing the age of this important paleontological site is critical to the correct assessment of Late Neogene climate evolution of the Antarctic region. These results affirm the Pliocene age of the Meyer Desert Formation paleoflora and associated fauna. The youngest marine diatoms reported herein are Fragilariopsis barronii, F. praeinterfrigidaria and Thalassiosira kolbei, which indicate the Meyer Desert Formation is less than ˜3.8 Ma. The dominance of marine neritic diatom Thalassionema nitzschioides and common occurrence of Chaetoceros spp. resting spores within sediment clasts of upper Miocene diatomaceous mud (up to 250 micrometers in size) establish open marine conditions of high fertility in Antarctic source basins where these floras were initially deposited.