Geochronology and geochemistry of pre-Jurassic superterranes in Marie Byrd Land, Antarctica

R. J. Pankhurst,1,2 S. D. Weaver,3 J. D. Bradshaw,3 B. C. Storey,1 and T. R. Ireland4,5

Abstract. Marie Byrd Land, Antarctica, is a major part of the proto-Pacific supercontinental margin. On the basis of new geochronological and geochemical data relating to its pre-Jurassic evolution, Marie Byrd Land is subdivided into western or interior ("Ross") and eastern or exterior ("Amundsen") provinces, equivalent to two superterranes in New Zealand. The Ross province is characterized by Cambrian metagraywackes and I-type orthogneisses dated at 505 ± 5 Ma by U-Pb SHRIMP (Sensitive High Resolution Ion Microprobe). Its magmatic record consists of Devonian-Carboniferous (375 ± 5 Ma and circa 339 ± 6 Ma), predominantly I-type granitoids, and further minor granitic magmatism in Permo-Triassic times. This Paleozoic history is comparable to that of the Gondwana margin in northern Victoria Land, western New Zealand, and SE Australia. The Amundsen province has no observed Paleozoic graywacke succession; evidence from Rb-Sr and U-Pb SHRIMP dating supports calc-alkaline granitoid events in Ordovician/ Silurian (450-420 Ma) and Permian (276 ± 2 Ma) times. The latter may be the previously unknown source of Permian volcanic detritus in the Ellsworth and Transantarctic mountains. The Amundsen province is considered to be the equivalent of the Median Tectonic Zone of New Zealand, and arc magmatism of comparable ages is found in the Antarctic Peninsula and Thurston Island. The underlying lithosphere of the two provinces may be distinguished by Nd isotope data; granitoids and metasedimentary rocks of the Ross province have Meso-Proterozoic Nd model ages, generally 1300-1500 Ma, compared to 1000-1300 Ma for the Amundsen province. On the basis of published palaeomagnetic data, the two provinces amalgamated to form Marie Byrd Land in mid-Cretaceous times, only shortly before rifting of the New Zealand continental block away from Antarctica.

1. Introduction

Marie Byrd Land (Figure 1) is the largest physiographical region of West Antarctica. Its geological exploration was initiated by U.S. expeditions following R. Byrd's 1929 flights of discovery, and concentrated on the Ford Ranges in the extreme west. The remainder of the coastal region has been investigated geologically by two international teams: the U.S. Marie Byrd Land Survey of 1966-1968 [Wade, 1967; Ipatin and Orlenko, 1974] and the South Pacific Rim International Tectonics Expedition (SPRITE) of 1990-1993 [Bradshaw et al., 1991]. Whereas outcrop in the hinterland is mostly restricted to Cenozoic volcanic rocks, the coastal areas reveal an older basement, intruded by Cretaceous plutonic rocks and overlain by their volcanic counterparts.

The pre-Mesozoic history of Marie Byrd Land provides direct evidence for the tectonic evolution of this large continental area within the supercontinent of Gondwana, which broke up in Jurassic-Cretaceous times; its significance to the proto-Pacific margin of the previous, Neoproterozoic, supercontinent of Rodinia also has to be evaluated. Although Marie Byrd Land is usually regarded as a single continental block, SPRITE palaeomagnetic studies have suggested that it consisted of two microplates in Cretaceous times [DiVenere et al., 1995]. Similarly, the pre-Mesozoic rocks are thought to comprise two major belts that can be correlated with superterranes identified in the originally contiguous New Zealand continental block [Bradshaw et al., 1997]. Both these interpretations depend heavily on unpublished geological, geochemical, and geochronological data derived from SPRITE work. This paper reviews the pre-Jurassic geology of Marie Byrd Land, bringing together this new information and published studies, and makes some broad correlations with the geology of the once surrounding parts of Gondwana. The data are presented in a roughly west-east geographical sense (Figure 1).

2. Analytical Methods

Isotopic data presented here include both Rb Sr and Sm-Nd whole rock analyses carried out at the Natural Environment Research Council Isotope Geosciences Laboratory, Keyworth (procedures as by Pankhurst et al. [1993]). Results are listed in Tables 1 2. U-Pb zircon analyses were carried out using the SHRIMP ion microprobe at the Australian Na-