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Ice mass fluctuations in Victoria Land, Antarctica

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During the 1980–81 field season we conducted a two-part program: the first part was spent on the Rennick Glacier in northern Victoria Land, and the second in the ice-free valleys of southern Victoria Land. The primary objective of the program was to help elucidate the glacial and climatic history of Transantarctic Mountains ice masses by interpreting the records available from the spectrum true glaciers to rock glaciers.

The northern Victoria Land portion of the study is an offshoot of a reconnaissance glacial geologic investigation conducted during the 1974–75 field season (Mayewski and Attig 1978; Mayewski, Attig, and Drewry 1979). Specifically, the 1980–81 season's work involved (1) completion of the glaciogeomorphic mapping of the Morozumi Range region (figure 1) and (2) implantation of experiments designed to assess the responsiveness of selected ice masses in this general region since they are differentially affected by the continuing "drawdown" of the surface of Rennick Glacier (Mayewski et al. 1979). The experiments are designed to record mass balance, velocity, and strain (figure 1) on two alpine glaciers and Rennick Glacier to clarify their current dynamics. In addition, a radio-echo sounding program is being undertaken to model the effects of subglacial topography on the dynamics of these ice masses and to evaluate total ice volume fluxes. During the 1981–82 field season, all aspects of the study previously mentioned will be expanded and remonitored and more ice cores will be collected from selected glaciers for purposes of developing a mass balance record. This mass balance record will be interpreted using ice chemistry as a seasonal and source indicator, with dating calibration to be provided by β-activity measurements on the core samples.

The second phase of this project, begun during the 1979–80 field season (Mayewski and Hassinger 1980), is a study of the relative age and origin of glacio-geomorphic deposits located in the North Fork of Wright Valley and of rock glaciers found throughout the ice-free valleys. Results from this study have been used to construct a framework of climatic change for western Wright Valley and to provide an analysis of the formation and dynamics of antarctic rock glaciers.

Three groups of features including glacial deposits, contemporaneous rock glaciers, and relict mass-movement features have been identified in the North Fork area on the basis of stratigraphic relationships and examination of surface morphology. Relative ages of these deposits were estimated on the basis of standard antarctic clast weathering techniques and analysis of subsurface structure as inferred from shallow geophysical sounding (Bell 1966).

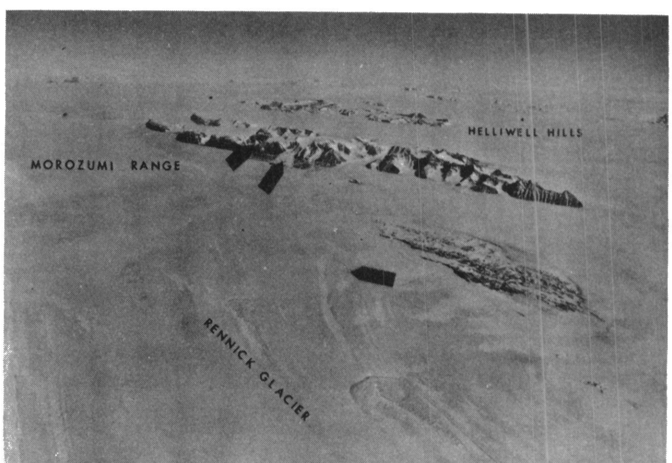

Figure 1. Location map of study area with location of mass balance/velocity/strain nets referred to by arrows. (Photo TMA 867, number 190 F-33, U.S. Navy)

Data from 15 sites were used to summarize the weathering of deposits found in the North Fork. Comparison of weathering data obtained for these deposits was also used to date them (relatively) with respect to glacial deposits studied in the eastern portion of Wright Valley by other workers. A total of 32 shallow seismic refraction profiles and 52 resistivity profiles was used to characterize the subsurface structure of the rock glaciers in the ice-free valleys as well as the glacial deposits found in the North Fork region. Geophysical information for deposits found in North Fork is summarized in figure 2. Glacial deposits, interpreted to be predominantly ice-free to a minimum depth of 20 meters, were found to contrast with rock glaciers in which frozen material was found within 0–60 centimeters of their surfaces. Profiles taken along the valley floor of North Fork illustrate the importance of collecting both electrical and seismic data, since a low velocity and, therefore, a hidden refractor of unknown material is indicated at a depth of 4 meters by a sharp decrease in apparent resistivity.

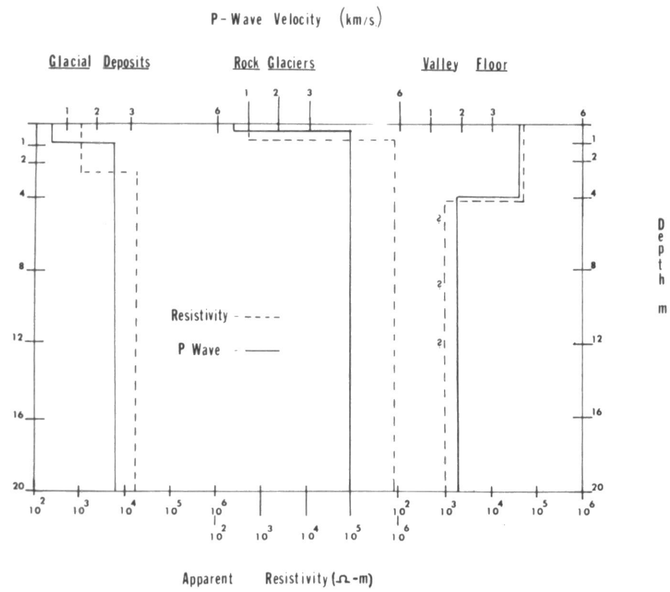

Figure 2. Seismic and resistivity characteristics with depth for the surficial deposits in North Fork, Wright Valley. km/s = kilometers per second; m = meters; Ωl-m = ohm-meters.

The dynamics of nine rock glaciers (see map, Mayewski and Hassinger 1980) have been examined in detail by means of velocity/strain networks and micromovement studies, the implementation of which was completed during the 1980–81 season. Reduction of data from a 10-year time series for a prominent rock glacier found in the North Fork area has yielded horizontal velocities of approximately 1–5 centimeters per year and velocities perpendicular to the surface of the rock glacier from −1.4 to +0.51 centimeters per year. Two-dimensional, infinitesimal strain, calculated from the relative movement of survey stakes, is characterized by principal strain rates of .000312 to −.000998 per year inclined at approximately 20° to the long axis of the rock glacier. These data are regarded as evidence of the very low levels of activity currently displayed by these mass-movement features. Photographic comparison of ten 1-meter by 0.5-meter survey sites over a 1-year period yielded higher strain rates on the order of .01 per year. Data from the remaining eight movement experiments are expected to yield usable movement data in 3 to 5 years.

Environmental variables associated with rock glacier sites, including geographic proximity to moisture sources, incidence of solar radiation, lithology of source material, and geometry of site location, also have been examined in light of their influences on the development of rock glaciers.

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