Table 1

	Al	AlOH	AlO
α	+ 0·0008	+ 0·0034	− 0·0027
β	0·0019	0·0031	− 0·0017
γ	0·0026	0·0032	0·0008
δ	0·0018	− 0·0002	0·0019
Density (g/cm³)	0·0038	0·0051	− 0·0035
Volume (cm³/mole)	0·325	0·054	1·05

Figures given are for increments of 1 per cent (Ps + Pm). Volume and density changes for the range 0–50 per cent (Ps + Pm) were calculated from Seki's data (ref. 2), and for 50–60 per cent (Ps + Pm) from the observed density and analysis of the Langban mineral (ref. 3).

The results in Table 1 imply that minerals of identical bulk composition can exhibit a wide range of physical properties, depending on the manner in which iron and manganese are distributed between the sites. Zambonini[4] has sought to explain the extreme variability of the optical properties of zoisite and clinozoisite in this way.

In epidote or piemontite formed at high temperatures, the iron and manganese will tend to be more evenly distributed between the sites; since the sites have very different volume characteristics, the distribution will also be pressure sensitive. Epidote is thus one of the few minerals capable of simultaneous application as a geothermometer and as a geopiezometer. Application of the phase rule shows that any observed distribution of iron or manganese uniquely determines the pressure and temperature of formation, and is independent of the composition of the fluid phase.

Table 2

	Al	AlOH	AlO
Iron	0·400	nil	nil
Manganese	0·425	0·675	0·285
Aluminium	0·125	0·325	0·715

A direct determination of the iron contents of the Al, AlOH and AlO sites in the iron-rich (47 per cent Ps) King Island epidote[5] is now being made by single crystal methods; the Langban piemontite[3], with 59·6 per cent (Ps+Pm), is also under investigation, but in the latter case rough estimates of the site populations are possible from the optical data, and are presented in Table 2. It has been assumed that all iron entered the Al site, and that this site contained a total of 27·5 per cent (Ps+Pm).

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R. G. J. STRENS*

Department of Geology,
University of Texas,
Austin, 12.

* Present address: Department of Geology and Geophysics, University of California, Berkeley 4.

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GEOPHYSICS

Rapid Advance of Glacier in Northern Ellesmere Island

OTTO FIORD, on the north-west coast of Ellesmere Island, extends for about 100 km eastward and north-eastward from Nansen Sound. The tide-water glacier at its head in 81° 20′ N., 84° 40′ W. drains the ice cap between Tanquary Fiord to the south and Phillips Inlet on the north coast of the Island. This ice cap constitutes one of the most extensive, unbroken areas of land ice in the Canadian Arctic, and maintains a general elevation of 1,800 m over an area of about 2,000 km²; the Otto Fiord glacier is by far its largest outlet on the west side. The glacier flows down from the elevation of about 1,800 m to sea-level in a straight valley 35 km long and 4–6 km wide between rugged mountains and nunataks. Neither glacier nor ice cap has been visited on the ground.

In June 1963, on a flight from Emma Fiord near the mouth of Nansen Sound to the Defence Research Board's field station at the head of Tanquary Fiord, I passed over this glacier and was impressed by its very highly disturbed appearance with which very few glaciers in northern Ellesmere Island offer any comparison. In the lower 25 km of its course, the surface showed the intense crevassing of a fast-moving ice stream. Subsequent examination of air photographs taken in 1950 and 1959 showed a very remarkable change both of the surface and in the terminal extent of the glacier in the nine-year period. All the crevassing had occurred during this period, all the surface melt streams so typical of glaciers in this region in summer had been obliterated, and stagnant marginal ice had been overridden. The terminus of the glacier, grounded near sea-level in 1950, had by 1959 advanced about 3 km as a floating tongue with calving of many icebergs. Considerable breakaway of the tongue occurred in the period July 7–August 17, 1959, as shown by air photographs of these dates.

There is no doubt that the Otto Fiord glacier advanced catastrophically between 1950 and 1959. Unfortunately there is no photography or observation during the intervening period to indicate when this advance may have started, except for the observation by Dr. R. Thorsteinsson of the Geological Survey of Canada that there were very few icebergs in the outer 50 km of Otto Fiord in the spring of 1956. The cause of this advance is a matter of speculation, although similar advances have been recorded in Alaska, Svalbard, the Karakoram, Chile and elsewhere. Previous catastrophic advances have been associated with a high annual accumulation, whereas measurements in northern Ellesmere Island indicate a mean annual accumulation not exceeding 20 g cm⁻². It could reasonably be supposed that sudden glacier advances would be even more uncommon in this area of low accumulation than elsewhere; in fact I have been unable to find any previous record of such an advance in the Canadian Arctic. Robin[1] has shown that these advances may be cyclic events, and that a rise from temperatures below melting point at the base of a glacier may provide the essential key to the mechanism. The deduction by Müller[2] of a temperature close to melting point in the lower half of a glacier in Axel Heiberg Island serves to emphasize the plausibility of the Robin hypothesis for sub-polar glaciers. A further report on the Otto Fiord glacier, illustrated with photographs, is in preparation. The likelihood of similar reactions by other glaciers in northern Ellesmere Island and elsewhere in the Canadian Arctic cannot be overlooked.

G. HATTERSLEY-SMITH

Geophysics Section,
Defence Research Board,
Ottawa.

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GEOCHEMISTRY

Evidence from Chemical Diffusion of a Climatic Change in the McMurdo Dry Valleys 1,200 Years Ago

LAKE VANDA (77° 35′ S., 161° 39′ E.) is 5 miles long, 1 mile wide and occupies the lowest part of the Wright Valley, an ice-free valley in Victoria Land, Antarctica. This lake has no outflow and is supplied from the east with melt water from the Wilson Piedmont Glacier via the 18-mile-long Onyx River. This River, under present climatic conditions, flows for only about sixty days every