gence). An examination of samples taken at 40-cm. intervals down cores from both north and south of the Polar Front shows that several cores located north of the Polar Front contain alternating layers of the two faunas, whereas cores located at the south show no such faunal fluctuations. If the alternating faunal zones observed in the northern cores are caused by a shift in the position of the Polar Front, then the data collected so far suggest that the Polar Front today may be as far south as it has been during the time period represented by the cores sampled.

Other changes are exhibited by 10 cores from the area. In these cores there is an abrupt change from a fauna composed predominantly of recent species, the majority of which are not found living in Antarctic waters today. This change in the radiolarian assemblage is accompanied in 80 cores by a large decrease in other siliceous or calcareous organisms. In two cores the carbonate content drops from 40–60 per cent to zero. In one core the older assemblage is associated with abundant discoasters and on this basis is tentatively assigned a Late Tertiary age.

The cause of the change in planktonic assemblages from Late Tertiary to Quaternary is not known, but it is suggested that it may be due to a change from a relatively stable stratification of the Antarctic Ocean during Late Tertiary to a stronger degree of vertical convection in the Quaternary associated with the cooling of this part of the world during the growth of the Antarctic ice cap.

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### Lithium Metasomatism Around Pegmatites

A widespread exogenetic effect accompanying the crystallization of lithium pegmatites is the introduction of small amounts of lithium into the wall rocks. Lithium is not found in altered wall rock around pegmatites that do not contain independent lithium minerals. This metasomatic lithium is housed in a number of different minerals, especially muscovite, biotite, tourmaline, and holmquistite. Lithium-bearing hedenbergite and hornblende each have been reported from a single deposit. Likewise, lepidolite and zinnwaldite have each been reported once, but proof of their identities has not been given. Thus it may be affirmed that the major pegmatic species (spodumene, lepidolite, petalite, amblygonite, Fe-Mn-Li phosphates) are not formed exogenetically.

Mineralogically, two types of lithium metasomatism are known. (1) The lithium is restricted to combinations of muscovite, biotite (usually also contains Li, Rb, Cs) and tourmaline. This type occurs typically in micaceous schists or gneisses around zoned or structurally complex pegmatites that contain lepidolite, amblygonite, Fe-Mn-Li phosphates ± spodumene. (2) The lithium occurs chiefly in holmquistite (± a narrow Li-biotite zone closer to the pegmatite). This is developed invariably in hornblendic wall rocks around unzoned, poorly zoned (Kings Mtn. type), or zoned pegmatites that contain early-crystallized spodumene, usually as the sole lithium species, or with petalite, rarely with lepidolite.

The number of holmquistite occurrences is now known to be ten, with a new discovery at Bernic Lake.

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### Properties of the Crust

Early refraction studies of the crust used widely spaced observing points. Consequently, secondary arrivals, including possible reflections, could not be identified. This required the use of first arrivals, which limited the definition of the method.

Under the Vela Uniform project for the improvement of seismology, techniques and instrumentation have been developed closely paralleling those used in the study of sedimentary columns: continuous profiles, close spacing of observation points, high recording speed, use of magnetic tape recording, etc. These techniques have been applied widely in the United States, less widely in Canada; analogous techniques are well advanced in the Soviet Union.

The crust in continents varies from a thickness of about 20 km. in some coastal areas to as much as 50 km. in high plateau areas. Over most continental areas of moderate elevation the average thickness is 35 km. The number of layers in the crust is open to question. It is generally accepted that there are two layers, an upper granitic one and a lower basaltic one, but these are clearly defined only in some high plateau areas. In most regions a model involving a functional increase of velocity with depth fits the data as well as any system of discrete layers.

Most recent studies show no simple relationship between crustal thickness, surface elevation, and gravity values. Isostatic compensation may be accomplished through variation in the thickness, or the mean density of the crust, or by mass redistribution in the mantle.

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### Genetic and Geometric Relations Between Structures in Basement and Overlying Sedimentary Rocks, with Examples from the Colorado Plateau and Wyoming

Field studies of jointing, faulting, and folding in the San Juan-Grand Canyon region, Arizona, and the Bighorn-North Laramie region, Wyoming, show that tectonic movements are primarily vertical. Maximum deformation of the rocks occur along narrow, linear zones which appear to follow elements of a primordial fracture pattern in the Precambrian basement. Sedimentary rocks play a passive role in the formation of folds and structural lineaments.

Fold geometries are determined by the developing geometry of the basement surface. The basic causes and mechanisms of deformation are generated in basement rocks below the level of the sedimentary strata. Structures in the sedimentary strata are of secondary origin, generated as a result of folding following basement deformation.

Prominent fracture trends of Precambrian age in the basement rocks of the Grand Canyon region are present as major elements of the joint patterns in overlying sedimentary rocks.

Large-order structural lineaments in the Bighorn region are long, narrow zones of deformation in sedimentary rocks which reflect deformations in the underlying basement rocks. Areally, structural lineaments follow some element of the regional fracture pattern.

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### Normal and Reverse Pleochroism in Biotite

Normal biotite has the absorption formula $Y > Z >> X$ with Y reddish brown, Z greenish brown (thick sections only) and X pale brown. Rarely biotite is pleochroic with absorption $X >> Y > Z$. Blue River, B. C., biotite is of the second ("reverse") type with the pleo-