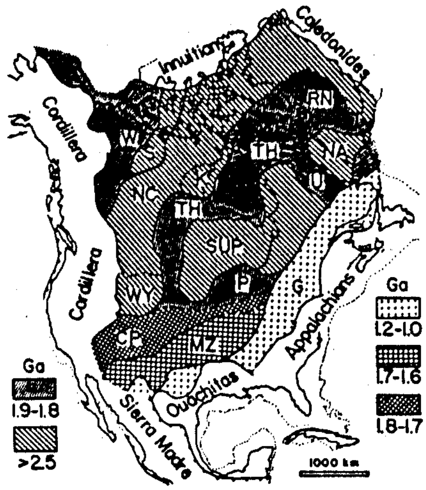
ON THE POSSIBLE OPHIOLITIC ORIGIN OF SOME SLAVE PROVINCE GREENSTONE BELTS; T.M. Kusky, Dept. of Earth and Planetary Science, The Johns Hopkins University, Baltimore, MD 21218; W.S.F. Kidd, Dept. of Geological Sciences, State University of New York at Albany, 1400 Washington Ave., Albany N.Y. 12222; D.G. DE PAOR, Dept. of Earth and Planetary Sciences, The Johns Hopkins University, Baltimore, MD 21218; C. SIMPSON, Dept. of Geological Sciences, Virginia Polytechnic Institute and State University, Blacksburg, Va. 24061; C. ISACHSEN, Dept. of Earth and Planetary Sciences, Washington University, St. Louis, Missouri 63130; D.C. BRADLEY, and L. BRADLEY, Lamont Doherty Geological Observatory of Columbia University, Palisades, New York, 10964

The origin of Archean granite-greenstone terranes, and their relationship to mechanisms of planetary heat loss during the early history of the earth, remains one of the most fundamental unanswered questions in geology. The creation, aging, and destruction of oceanic lithosphere, through plate tectonics, is recognized as the dominant mechanism of planetary heat loss for the Phanerozoic. No such unifying theory has been accepted for the early (Archean) history of the earth.



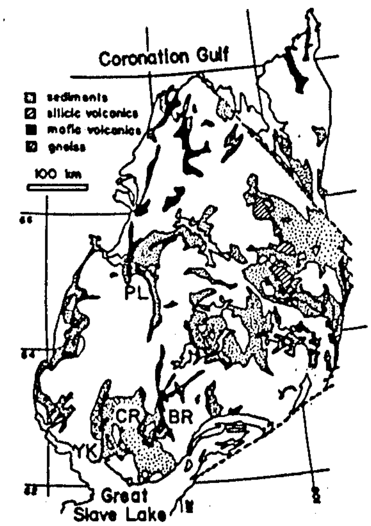


Fig. 1. Location of the Slave Province (S) in cratonic North America. W, Wopmay Orogen; NC, northwest Churchill Craton; K, Kaminak Craton; TH, Trans-Hudson Orogen; RN, Rinkian--Nagssugtoqidian Orogens; NA, North Atlantic Craton; U, Ungava Orogen; SUP, Superior Craton; P, Penokian Orogen; CP, Central Plains Province; M, Mazatzal Province. After (1).

Figure 2. Generalized geology of the Slave Province, showing locations of greenstone belts discussed in text: YK, Yellowknife Belt: CR, Cameron River Belt; BR, Beaulieu River Belt; PL, Point Lake Belt. After (2).

The Slave Province, located in the northwestern portion of the Canadian Shield (Figures 1 and 2), is perhaps the best-exposed Archean granite greenstone terrane. It has escaped tectonism since Archean times, excepting a period of indentation tectonics and strike slip faulting related to Wopmay orogenesis at 1.9 Ga. Our mapping and structural analysis of the 2.6 Ga old greenstone belts and their relationships to older (up to 3.5 Ga) gneissic terranes has provided some insight towards mechanisms of Archean heat loss. Greenstone belt stratigraphy in the western Slave Province typically grades downwards from detrital sediments, into a thick pillow lava section, and down further into a mixed dike and pillow lava unit. Locally, the upper volcanic-rich section has been observed to overlie a sheeted dike complex consisting of 100% diabase and gabbro dikes, in turn underlain by massive gabbros (3, 4). Significant amounts of highly strained ultramafic rocks were discovered at the bases of all the greenstone belts studied (Cameron River, Point Lake and Beaulieu River Belts; 4). Some of the ultramafics are clearly cumulate in origin, while others have chemical characteristics similar to younger mantle peridotites. In general, cumulate ultramafics occur higher in the structural succession than the putative mantle peridotites. The above sequence of rocks is essentially identical to Phanerozoic ophiolite suites. At least part of the volcanic/mafic-plutonic portion of western Slave Province greenstone belts are accordingly interpreted as obducted fragments of Archean oceanic lithosphere.

Pillows, pillow selvages, amygdules, and conglomerate clasts have been measured for strain analysis. These reveal a heterogeneous regional strain which, in some places, falls in the prolate field. Some of the apparent prolateness could, however, be the result of a flattening strain superimposed on

Archean Ophiolites In The Slave Province

Kusky, T.M., et al.,

pillows which were originally tubular rather than ellipsoidal. Our mapping has revealed the presence of a major high strain zone between the greenstone belts and structurally underlying quartzofeldspathic gneissic rocks in all three widely separated areas where we have examined the boundaries. These high strain zones are complex and include lenses of metapelites, iron formation, mylonitic amphibolites, mafic rocks derived perhaps from volcanics, subvolcanic and plutonic rocks, and ultramafic rocks (Figure 3). The gross arrangement of rock types, with exoctic lenses enclosed in a metapelitic matrix, bears many similarities to younger melange zones. Microfabric analysis indicates fairly widespread irrotational strains within the detachment zones, although some units do contain rotated porphroclasts and other kinematic indicators with a thrust sense of displacement. Underlying quartzofeldspathic gneissic rocks are mylonitic along their boundaries with the greenstone belts in the three areas we have mapped. In the Point lake area sense of shear indicators are consistent with those in the overlying melange zone, while in the Cameron River area the mylonites have to date produced ambiguous results. Structural relationships in these high strain zones are similar to those found beneath obducted Phanerozoic ophiolites (including the Bay of Islands Complex in Newfoundland, and the Semail Ophiolite in Oman). However, the metamorphic arrangement is not the same: unlike the ophiolite cases, the greenstone belts have been modified by subsequent plutonism. In the younger examples, dynamo-thermal aureoles and associated ophiolitic melange are inferred to mark detachment and movement zones initialized in the oceanic realm. A similar origin is proposed for the Archean examples in the Slave Province.

Greenstone belt stratigraphy in the Slave Province may contain in part a record of processes which occurred at Archean divergent plate margins. However, the structural state of most of the material we have seen is highly deformed and thus difficult to interpret. We suggest that ocean closing is recorded in the early deformation of these belts, particularly in the shear zones at the margins of the greenstone belts. Younger deformation and metamorphism has partially obscured this early history, but detailed structural analysis is capable of unraveling it in suitably well exposed locations. The recognition of Archean ophiolitic sequences and the ocean basins that they imply suggests plate tectonics has likely been the dominant mechanism of planetary heat loss throughout the Archean as well as the remainder of earth history. It remains to be established if these represent main ocean or alternatively back arc basin ophiolites. Further results, when coupled with data from other ophiolitic greenstone terranes (5, 6) may have implications for establishing the width of Archean oceans, and determining what plate velocities and boundary lengths were in the Archean relative to Phanerozoic times.

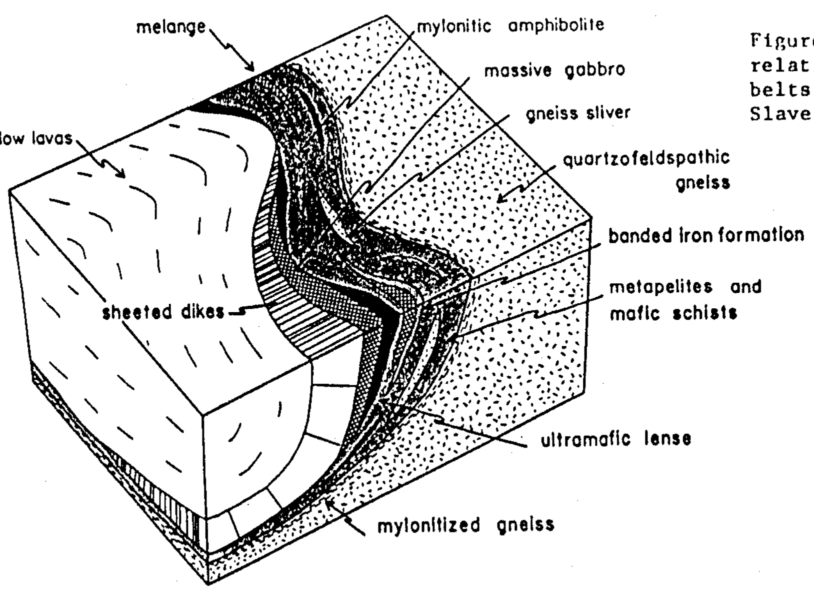


Figure 3. General model for contact relationship between greenstone belts and gneiss terranes in the Slave Province.

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