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**A CONTINENTAL RIFT MODEL FOR THE LA GRANDE GREENSTONE BELT;**
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Stratigraphic relationships and the geochemistry of volcanic rocks constrain the nature and timing of the tectonic and magmatic processes in the pre-deformational history of the La Grande greenstone belt in the Superior Province of north-central Quebec (Fig. 1). With the exception of a locality in the western part of the belt the lowermost supracrustals in this belt are obscured by syntectonic granitoid intrusives. The supracrustal succession in the western part of the belt consists of a lower sequence of immature clastic sediments and mafic volcanoclastics, overlain by pillowed and massive basalts (Fig. 1, A-A′). Further east, along tectonic strike, a lower sequence of mafic volcanoclastics and immature clastic sediments is overlain by a thick sequence of pillowed and massive basalts, and resedimented coarse clastic sediments and banded iron formation. These are overlain by massive basaltic andesites, andesites and intermediate volcanoclastics intercalated with immature clastic sediments (Fig. 1, B-B′). In contrast, in the eastern part of the belt lenses of felsic volcanics and volcanoclastics occur at the base of the succession and pillowed and massive basalts are overlain by komatiites at the top (Fig. 1, C-C′).

The lower sequences of clastic sediments in the central part of the belt reflect a mixed intrabasinal and extrabasinal provenance, but the upper clastic sediments have a uniquely extrabasinal tonalitic provenance. In addition metasedimentary and granitoid xenoliths have been found in the volcanic pile in the central and eastern parts of the belt and a local unconformable contact is believed to exist between the supracrustal succession and an underlying tonalitic basement in the west (1). Therefore a model in which the La Grande belt formed on a sialic crust is favoured.

The largest volumes of eruptive rocks in the La Grande belt are tholeiitic basalts (Fig. 2). These basalts are not primary mantle-derived liquids, but have undergone a polybaric fractionation history (1, 2 and 3). Their parental magmas are believed to have been basaltic komatiites (Fig. 2). The basaltic komatiites and most magnesian basalts lie along a steep slope in Al-Si space (Fig. 2) which is best explained by the fractional crystallization of orthopyroxene and olivine (4, 1). Co-existence of these two silicate phases and a liquid of basaltic composition is restricted

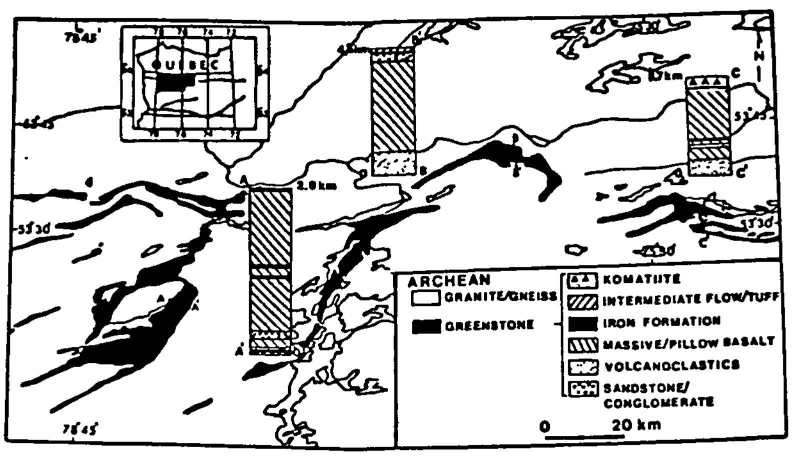


Figure 1 Geology of the La Grande greenstone belt.

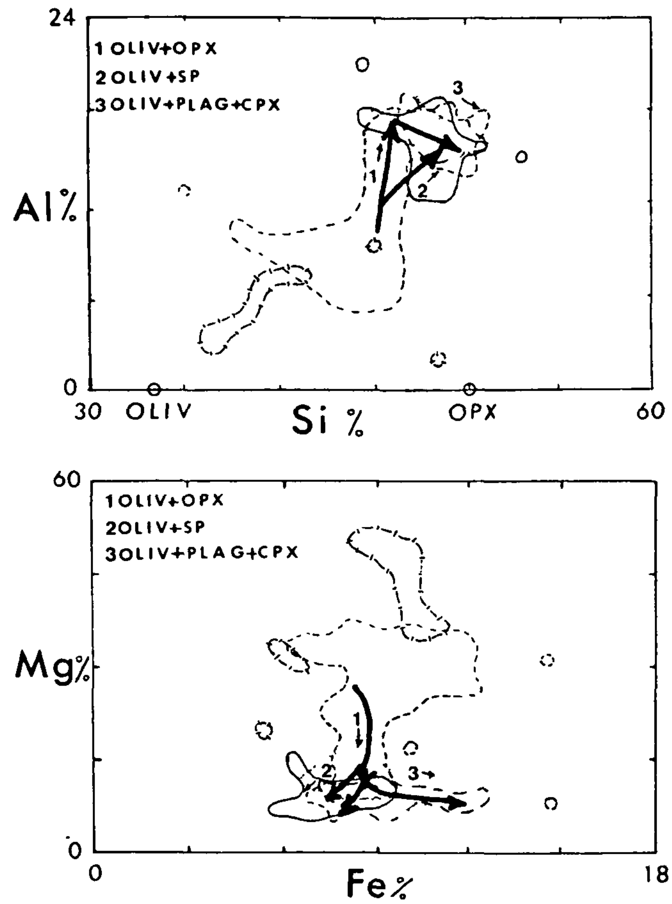


Figure 2 Al-Si and Mg-Fe in cation%. The solid line encloses basalts from section A-A', dotted line is basalts from section B-B', dash-bar and dash-dot are komatiites and basalts respectively from section C-C' and the dashed line includes komatiites and basalts from Lac Guyer (north of C-C').

to pressures on the order of 10 kb (5). Thus the basalts represent komatiitic liquids which have been modified by differing extents of fractionation at depths on the order of 30 km before migrating to higher levels in the crust (3, 1 and 6). A spectrum of basaltic compositions are found in the La Grande belt of which the endmembers are an Fe-enriched suite and those which have negligible Fe variation (Fig. 2). The Fe-enriched basalts have undergone extensive low pressure fractionation of a gabbroic assemblage, which is probably the result of a more protracted residence time in upper crustal conduit system than the relatively constant Fe group. The degree of fractionation of the komatiitic liquids and their location in space and time may reflect the variable efficiency of a crustal density filter (cf. 7). Thus, the occurrence of komatiitic lavas in the upper levels of the supracrustal succession may be due to late failure of the crustal barrier. Their restricion to the eastern parts of the belt may reflect development of a major rift only there. Ponding of mafic magmas within the sialic crust may have resulted in the melting of the crust and the early eruption of rhyolitic magmas in the east (4). Toward the central parts of the belt, komatiitic magmas ingested sialic crust, were modified by fractional crystallization and were ultimately erupted as basaltic andesites and andesites. These contaminated magmas are characterized by high compatible element (eg. Ni and Cr) and fractionated, enriched light rare earth element abundances (up to 100X chondrite) (8).

The La Grande greenstone belt can be explained as the product of continental rifting (6). The restricted occurrence of komatiites, and eastwardly directed paleocurrents in clastic sediments in the central part of the belt are consistent with rifting commencing in the east and propagating westward with time (Fig. 3). The increase in depth of emplacement and deposition with time of the lower three units (Fig 1, section B-B') in the central part of the belt reflects deposition in a subsiding basin (6). These supracrustal rocks are believed to represent the initial rift succession (c.f. 9). Model calculations (Fig.3) reveal that the extension factor for lithosphere neccessary to account for the observed initial subsidence in the central part of the belt (6) is comparable in magnitude with that measured in Modern sedimentary basins where the continental lithosphere is believed to have been rapidly thinned (10). The occurrence of clastic sediments of granitic provenance high in the succession in the central parts of the belt may reflect the uplift and erosion of marginal forebulges that formed as a result of lithospheric flexure.

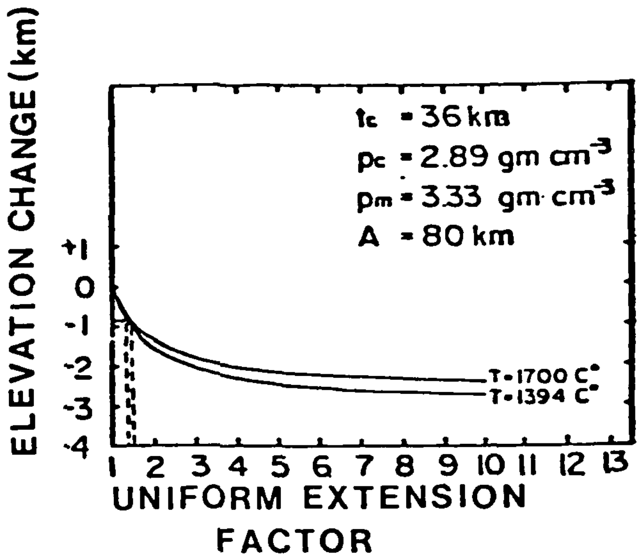


Figure 3 Initial elevation change versus uniform extension factor. For an initial elevation change of .9 km corresponding to the subsidence that is observed in the lower three units of section B-B′ corrected for the basin fill and 1 km of water requires a uniform extension factor of approximately 1.5. The symbols used are: crustal thickness (tc), crustal and mantle densities (ρc) and (ρm) respectively, temperature at the base of the slab (T) and lithosphere thickness (A). The thermal expansion coefficient used is $3.2 \times 10^{-5}$ °C. The calculations were performed using the method of Royden and Keen (11).

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