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SPECULATIONS ON NATURE AND EXTENT OF ARCHEAN BASEMENT IN LABRADOR AS INDICATED BY SR, ND, AND PB ISOTOPIC SYSTEMATICS OF PROTEROZOIC INTRUSIVES.

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Introduction. Sm-Nd and Rb-Sr isotopic compositions of mid-to late Proterozoic ($\sim$ 1.6-1.1 Ga) massif-type anorthosites and mafic intrusives in the eastern Canadian shield are correlated with geographic location (1,2). Complexes in the Grenville province have positive ε_{Nd} values and initial $^{87}Sr/^{86}Sr$ (I_{Sr}) generally less than 0.703, suggesting derivation from depleted mantle. In Labrador, similar complexes close to or northwest of a line roughly corresponding to the Grenville Front have negative ε_{Nd} values and $I_{Sr} > 0.703$. This contrast has been interpreted as reflecting either enriched mantle under the Nain Province (1), or contamination of the Nain intrusives with older crustal components (2). Pb isotopic compositions, however, favor the latter (3). We speculate here on the possibility of using these Proterozoic intrusives as tracers to characterize the nature and extent of older basement types in Labrador.

Harp Lake and Mealy Mountains Complexes. Our data base includes Sr, Nd, and Pb isotopic compositions of 1.6-1.65 Ga anorthosites and related rocks from the Harp Lake (Nain Province) and Mealy Mountains (Grenville Province) complexes, and also of later ($\sim$1.4 Ga) mafic dikes which crosscut them (Fig. 1) (3-6). The anorthosite complexes are large (7000-8000 km^2) composite massifs dominated by leucotroctolites and leuconorites, with minor ferrodiorites and gabbros (4). Both complexes are crosscut by an ENE-trending swarm of olivine diabase dikes with similar mineralogy and major and minor element chemistry (5,6). Mealy dikes yield a whole-rock Rb-Sr age of 1380 $\pm$ 54 Ma (Fig. 2) (6). Harp and Mealy dikes have been suggested as correlative with other gabbroic rocks of similar age in Ladrador, including the Shabogamo, Michael, and Flowers River gabbros, the Seal Lake volcanics, and the Kiglapait layered intrusion (5,6).

Mealy anorthosites have I_{Sr} = 0.7026 - 0.7032 and ε_{Nd} = +1.2 to +3.0 (computed for 1.65 Ga). Mealy dikes have I_{Sr} = 0.7025 - 0.7028 and ε_{Nd} = +3.8 to +5.6 (computed for 1.4 Ga). Both are consistent with derivation from mantle sources depleted with respect to Rb/Sr and Nd/Sm. Pb isotope data for Mealy anorthosites and dikes form a linear array between the evolution curves for model mantle (7) and average crust (8). This array is essentially equivalent to that for Proterozoic carbonatites, which Tilton (9) interpreted as reflecting depleted mantle.

Harp Lake samples show a much larger variation in isotopic composition (Figs. 2, 3). The major rock units of the Harp Lake anorthosite complex have I_{Sr} between 0.7039 and 0.7066, and ε_{Nd} between -2.4 and -6.0 (at 1.65 Ga). Harp dikes have I_{Sr} = 0.7032 - 0.7033 and ε_{Nd} = -0.3 to -2.3 (at 1.4 Ga). The Nd isotopic data for Harp dikes show a narrow range of $^{147}Sm/^{144}Nd$ (0.146 - 0.153), but plot along a $\sim$ 3.3 Ga reference line, probably reflecting mixing with an Archean component (Fig. 3). Harp Lake anorthosites and related rocks show a wide scatter in Pb isotope compositions, and can be interpreted as reflecting mixing between a depleted Proterozoic mantle component and an older component with extremely unradiogenic Pb.

Likewise, Harp dikes and plagioclase separates therefrom have very low $^{207}Pb/^{204}Pb$ for Proterozoic mantle-derived materials, and must be interpreted as reflecting contamination with U-depleted crustal material.

Possible Contaminants. Although we cannot constrain the precise nature of the contaminant, its composition must be such that it has essentially no effect on the major or minor element chemistry of Harp Lake samples, assuming that Mealy Mountains samples can be considered uncontaminated starting materials. Harp dikes show no noticeable enrichments in "crustal" components such as SiO_2, K_2O, Na_2O, etc. The most appropriate contaminant would have sufficiently low Rb/Sr, Sm/Nd, and U/Pb such that its isotopic compositions evolve to relatively low values of $^{87}Sr/^{86}Sr$, $^{143}Nd/^{144}Nd$, and $^{207}Pb/^{204}Pb$ by about 1.4 Ga.

The Harp Lake complex, and other Proterozoic intrusives in the Nain Province of Labrador were emplaced near the boundary between Aphebian (1.7 - 1.8 Ga) gneisses of the Churchill Province, and a belt of Archean gneisses with ages as old as 3.6 Ga, exposed along the eastern coast of Labrador (Fig. 1) (4,10). The Aphebian gneisses are considered to be reworked equivalents of late Archean ($\sim$2.7 Ga) materials similar to those in the Superior Province (11), and the older Archean gneisses of coastal Labrador have been correlated with the ancient gneiss terrane of West Greenland (e.g. 10).

Initial Sr and Nd isotopic compositions (at 1.4 Ga) of these gneisses are compared with those of Harp and Mealy dikes in Fig. 4. Data for the Churchill and Superior Provinces are McCulloch and Wasserburg's (11) composites for large areas of these terranes. The wide range in isotopic composition among Uivak gneisses is a likely consequence of early granulite facies metamorphism which produced low Rb/Sr and I_{Sr} in some areas (12,13). Among these possibilities, the most suitable contaminant for the Harp dikes would be Rb-depleted Uivak gneiss (component B, Fig. 4). Less than 10% of such a component added to Mealy dikes would produce the isotopic composition of the Harp dikes, assuming simple two-component mixing (Fig. 4). Although the Superior and Churchill Province composites would not appear to be appropriate contaminants, we cannot rule out as a possibility a Rb-depleted equivalent of such material, produced for example, by granulite facies metamorphism (component C, Fig. 4). This hypothetical component would be a less satisfactory contaminant in that it would require a larger degree of contamination (15 - 25%). Pb isotope systematics also favor an ancient gneiss-type contaminant (Uivak or Amitsoq gneiss) over late-Archean gneisses (Fig. 5).

Discussion. Although it remains speculative, it could be inferred from our data that the ancient gneiss complex exposed along coastal Labrador extends in the subsurface, beneath the Harp Lake anorthosite complex, and possibly as far west as the Labrador Trough, where the 1.45 Ga Shabogamo gabbros also have negative ε_{Nd} values of about -5 (14). Pb isotopic compositions of these, and other mafic intrusives in Labrador are clearly needed to evaluate this. It is possible, therefore, that the Archean North Atlantic craton is much more extensive than indicated by present surface exposures.

In any case, Proterozoic intrusives in the Grenville Province show no evidence of contamination with Archean crustal components. The Labrador segment of the Grenville Front, therefore, appears to mark the southern edge of the Archean craton in eastern North America. It is possible that this feature coincides with a suture, but if this is the case, it must be older than 1.6 Ga.

Fig. 1

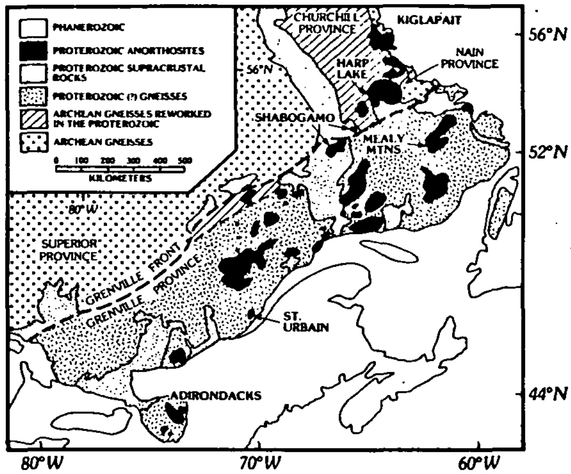


Fig. 2

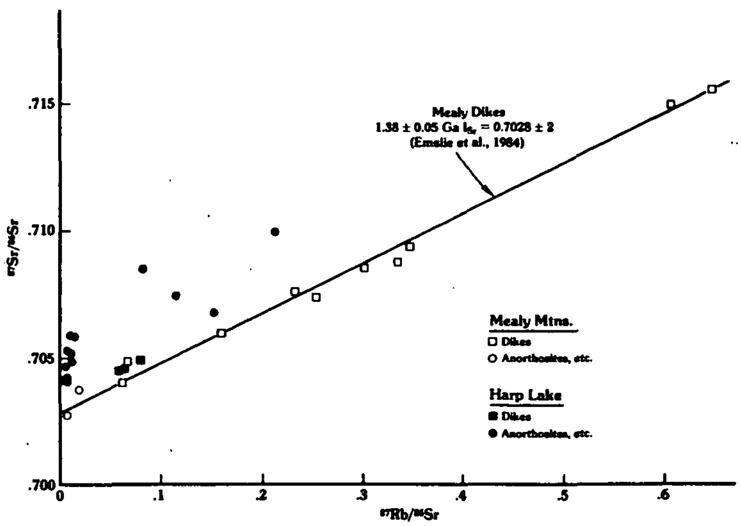


Fig. 3

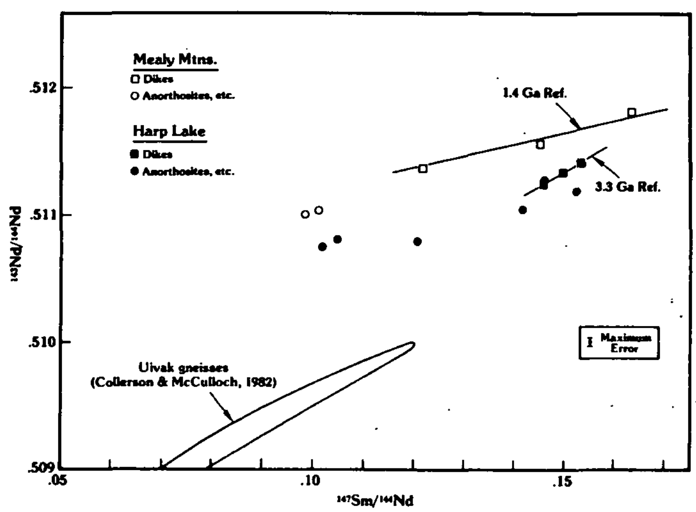


Fig. 4

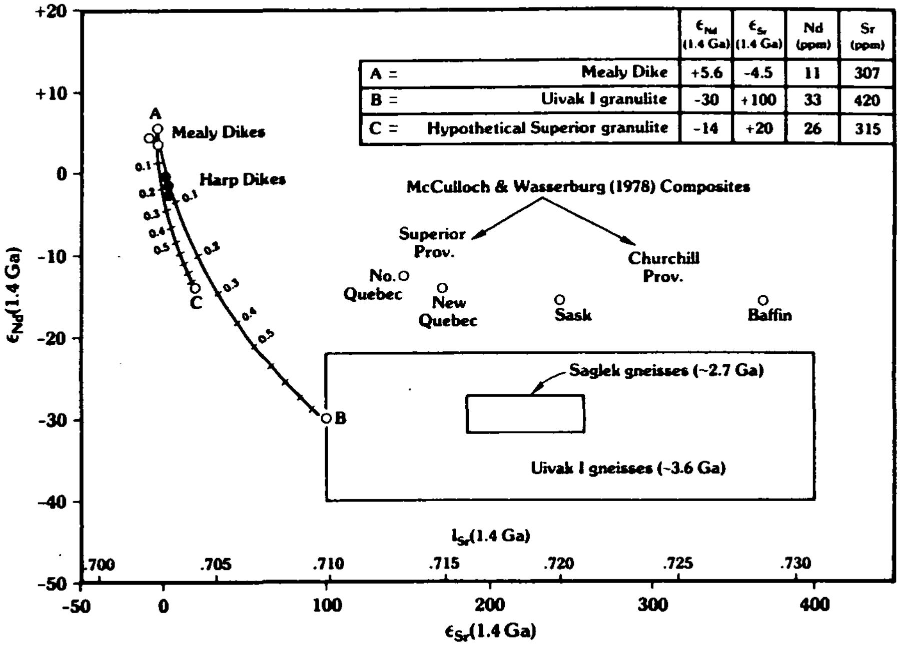
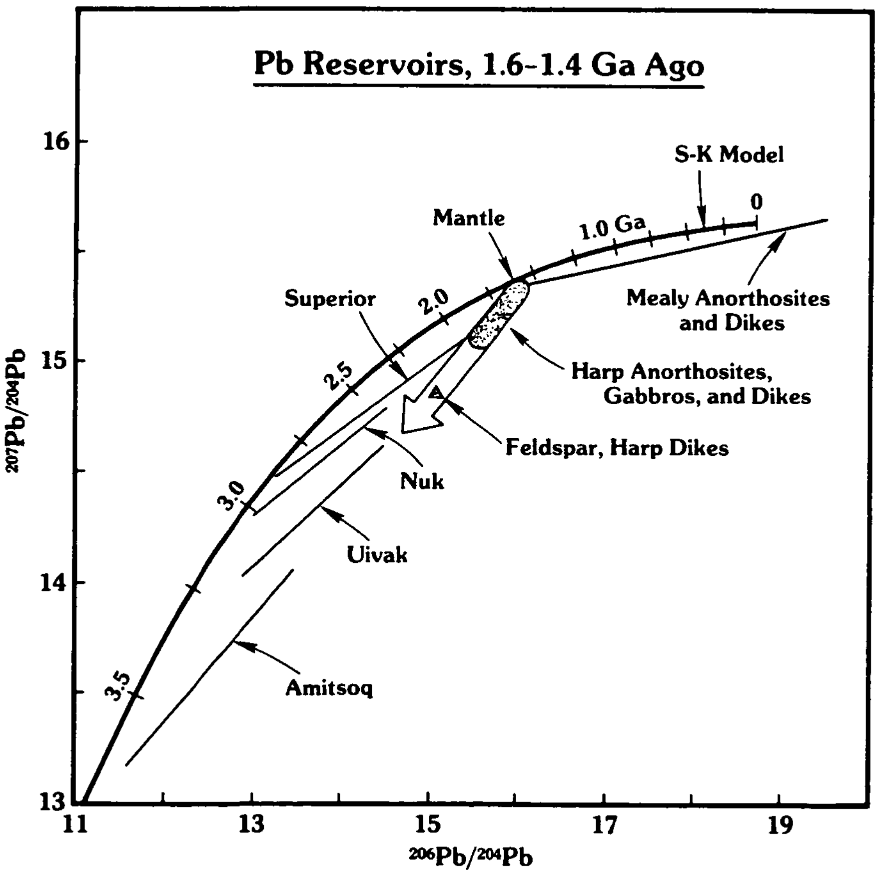

ϵ_{Nd} (1.4 Ga)
ϵ_{Sr} (1.4 Ga)
Nd (ppm)
Sr (ppm)
A = Mealy Dike +5.6 -4.5 11 307
B = Uivak I granulite -30 +100 33 420
C = Hypothetical Superior granulite -14 +20 26 315
Mealy Dikes
Harp Dikes
McCulloch & Wasserburg (1978) Composites
Superior Prov.
Churchill Prov.
No. Quebec
New Quebec
Sask
Baffin
Saglek gneisses (~2.7 Ga)
Uivak I gneisses (~3.6 Ga)
I_{Sr}(1.4 Ga)
ϵ_{Nd}(1.4 Ga)
ϵ_{Sr}(1.4 Ga)

Fig. 5


Pb Reservoirs, 1.6-1.4 Ga Ago
S-K Model
Mantle
1.0 Ga
Superior
Mealy Anorthosites and Dikes
Harp Anorthosites, Gabbros, and Dikes
Feldspar, Harp Dikes
Nuk
Uivak
Amitsoq
$^{207}Pb/^{204}Pb$
$^{206}Pb/^{204}Pb$

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