INAA AND RB-SR ISOTOPE ANALYSIS OF LAKE ST. MARTIN MELT AND COUNTRY ROCKS;

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The 24 km wide Lake St Martin (L.S.M.) crater structure in Manitoba (15°47'N, 98°32'NW) is situated in an Archean gneissic terrain near the eastern edge of the Paleozoic rocks overlying the Superior Province of the Canadian Shield. Detailed descriptions of the geological environment were provided by (1) and (2). Surface outcrop is rare, but an extensive drilling programme resulted in the recognition of a complex crater morphology with central uplift, various layers of melt rocks (and possibly one major sheet, as mentioned by (2)), and a crater fill of polymict fragmental and melt breccias. The petrographic work of (1,2,3,4) recognised characteristic shock metamorphic effects, such as planar elements or diaplectic glasses, in melt rock inclusions and polymict breccia constituents. The central uplift is composed of gneiss shocked to ~10 - 20 GPa. This has been taken as sufficient evidence to classify this structure as an impact crater. Two K-Ar ages for melt rock specimens reported by (1) place the crater (melt rock) -forming event into the period from 200-250 m.y. ago.

The incentive for our group to study L.S.M. specimens was a dual one: (a) to attempt to identify possible traces of a meteoritic projectile mixed into melt rocks and to obtain trace element information on the parent rocks of the melt (and on melt source and formation process); (b) to attempt to define better the crater age to improve crater age statistics (e.g. used for periodicity calculations (cf.(5)).

RESULTS: Abundances of 22 trace elements were obtained by INAA on 9 melt and 9 basement rock samples. The major REE result (Figs. 1 and 2) is that two basement rock components of granitic or granodioritic (sample 8-79, Fig.1) composition can be recognised contributing to the well-homogenized melt rocks (Fig.2) in a ratio of about 75:25. With regard to lithophile elements (Fig.3) the melt rocks are intermediate to the basement rocks (sole exception is melt rock sample 4-387 with exceptional Sc, U, (and Th) concentrations). Several melt rock samples are depleted in Cs if compared with basement rocks. Siderophile element concentrations (Ni, Co, Cr) are low in all analysed rocks (<27, <22 (but 4-387: 27), <123 ppm, resp.), and no enrichment of siderophiles (possible meteoritic contribution) could be detected (Ir < 1ppb). In a plot of Co/Cr versus Ni/Co ratios (Fig.4) all melt rocks, except sample 4-387, are again intermediate to analysed basement varieties. It seems doubtful as to whether sample 18A-78 really represents a third parent rock component, as there is some geochemical evidence that samples 18A-78 (altered feldspar, oxidized biotite) and 4-387 (mica and Fe-oxide fills in numerous vesicles) experienced severe alteration (complete removal of U, high Au, low K, Rb, Cs, Ba). The formation of L.S.M. melt rocks by mixing of crustal rock components (and the at least partial depletion of volatile elements - Cs,(Rb?)) would be consistent with an origin by impact.

All melt rock and basement rock samples as well as feldspar and pyroxene separates of two melt rocks were analysed for their Rb-Sr isotopic compositions (results: Fig.5). After exclusion of one pyroxene and one feldspar separate (affected by alteration or contaminated with unequilibrated parent rock inclusions), and data for 4-387, the remaining 8 whole rock melt samples and mineral separates define an isochron corresponding to an age of T = 220.5 $\pm$ 18 m.y.(1σ), I.R.=.7131$\mp$ 1. The melt rocks are isotopically equilibrated and with respect to the basement rock chemistry rather well chemically homogenized, as one could expect for melt rocks generated by impact (e.g. 6,7). The high initial ratio is consistent with the interpretation that the melt rocks were derived from a purely crustal source. Melt rock sample 4-387 plots on the basement rock errorchron (Fig.5), and evidently did not isotopically homogenize with the other melt rocks. This sample may have been produced by local melting (not even necessarily related to the 220 m.y. event; a pseudotachylite sample?); hopefully Rb-Sr mineral analysis on this sample can clarify this (compare results by (8) on Manicouagan melt rocks!).

The 9 basement rock samples yield an errorchron giving an "age" of 2771$\pm$220 m.y.(I.R. = .6997 $\mp$ 8). The scatter of data points can be explained by alteration or low-grade metamorphic processes. It is evident that no major thermal event affected the basement isotopic systematics between ~ 2.7 and 0.2 AE ago.

REFERENCES: (1) McCabe, H.R. and Bannatyne, B.B. (1970), Geol. Surv. Manitoba, Geol. Pap. 3/70, 79p; (2) SIMONDS, C.H. and McGee, P.E. (1970), Proc. Lun. Planet. Sci. Conf. 10th, 2493-2518; (3) Dence, M.R. (1970), Shock metam. at the L. St. M. Structure (pap. pres. to Ann. Meet. Geol. Assoc. of Can., Winnipeg; (4) Dence, M.R. (1972), The nature and significance of terrestr. impact structures (pap. pres. to 24th Int. Geol. Congr., IUGS, Montreal; (5) Durrheim, R.J. and Reimold, W.U. (this volume); (6) Reimold, W.U.. (1982) GCA 46, 1203-1225; (7) Reimold, W.U. et al. (1981) Contr. Mineral. Petrol. 76, 73-76; (8) Jahn, B.-M. et al. (1978) JGR 83, 2799-2803.

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Lake St. Martin melt rocks

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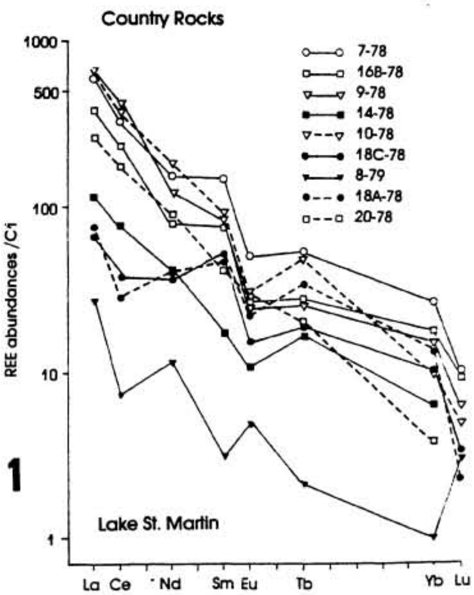

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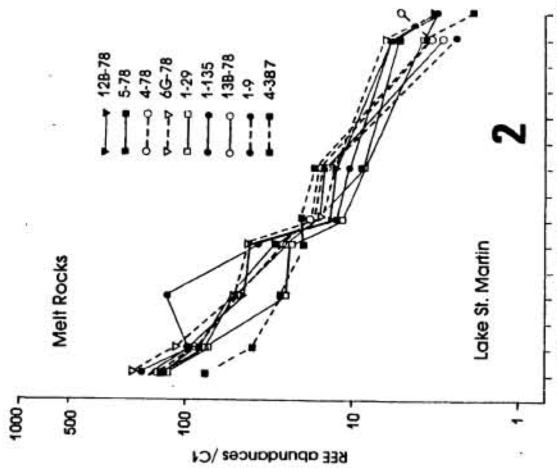

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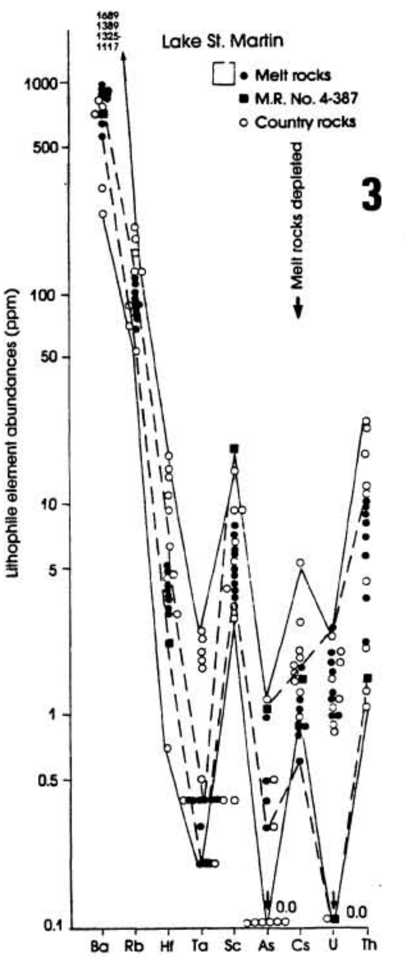

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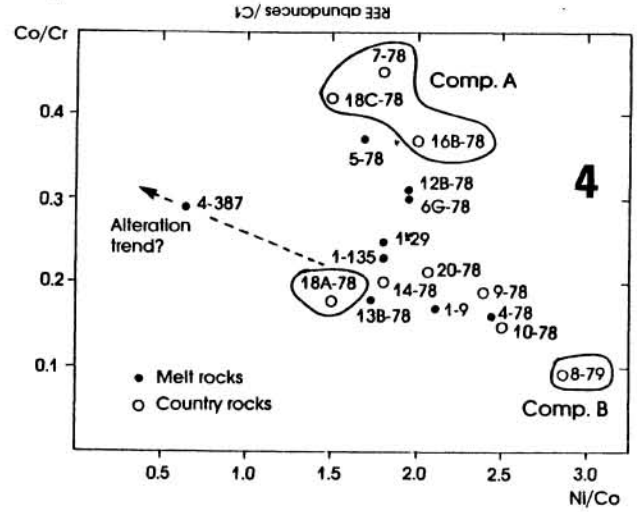

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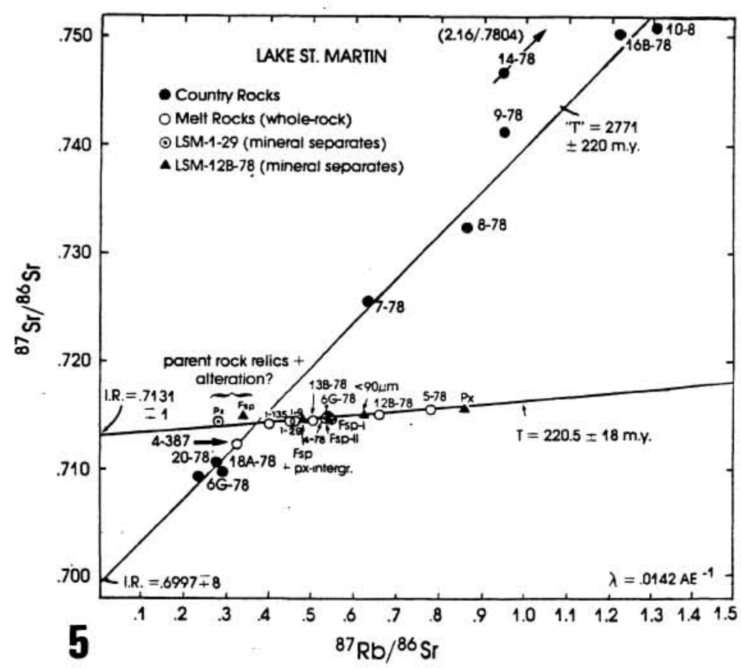

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