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Two Melts in the Sudbury Igneous Complex

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The Main Mass of the 1.85 Ga Sudbury Igneous Complex (SIC) has been interpreted as an impact melt sheet that differentiated as a closed system, from one 2-3 km-thick layer or two segregated layers [1-2] with lateral variations produced by mineralogical-textural-geochemical-isotopic heterogeneities in the target rocks [3]. Geochemical data for 7 complete and several partial traverses across the up to 2000 m-thick lower noritic member of the SIC on the North Range (NR) and South Range (SR) show not only significant lateral differences in parental melt compositions, but also vertical variations, indicating that the norites were derived from at least two melts: 1) one containing (broadly) 4% MgO and 61-62% SiO_2 with 0.9% TiO_2, 16% Al_2O_3, 8% FeOt, 6% CaO, 3% Na_2O, 2.5% K_2O, 0.2% P_2O_5, 100 ppm Cr, higher abundances of Cs-Rb-Ba-Y-Zr-Nb-Ta-Th-U, and lower abundances of Sr, which formed the lower part of South Range norite, and 2) one containing (broadly) 6% MgO and 57% SiO_2 with 0.8% TiO_2, 19% Al_2O_3, 8% FeOt, 9% CaO, 3% Na_2O, 1% K_2O, 0.1% P_2O_5, 60 ppm Cr, lower abundances of Cs-Rb-Ba-Y-Zr-Nb-Ta-Th-U, and higher abundances of Sr, which formed SR Melanorite and overlying SR Norite, including a discontinuous melanorite horizon, and all of the norite on the NR. Zr/Y and Nb/Th vary systematically with degree of Opx-Plag accumulation and fractional crystallization, suggesting that zircon and ilmenite were part of the accumulating/fractionating assemblage. Data for two of the more detailed traverses [4-5] are shown in Figure 1.

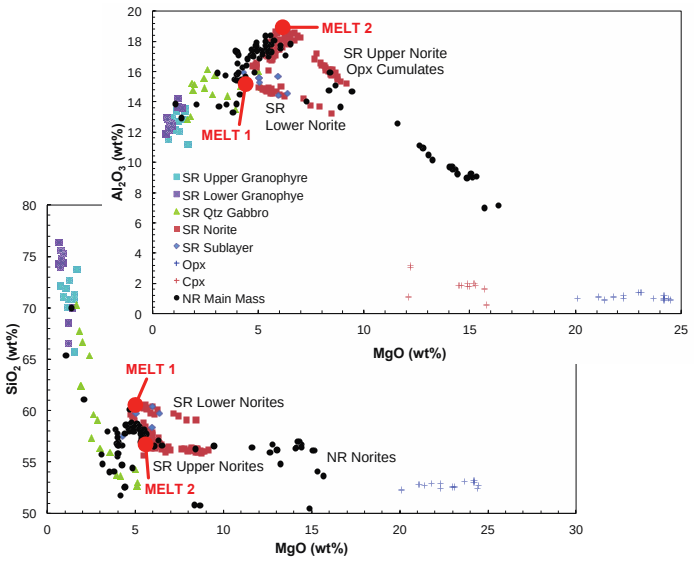

Figure 1. SiO_2 and Al_2O_3 vs MgO diagrams showing two cumulate trends defining two parental melts for the norites.

Both liquids appear to lie on the Opx-Plag cotectic. The trends in the sequence therefore represent a *reversal* from 1) Opx-(Zir)-(Ilm) and Plag-Opx-(Zir)-(Ilm) cumulates (SR Sublayer + SR Qtz-Rich Norite + SR Lower Norite) formed from a *more evolved* melt to 2) Opx-(Zir)-(Ilm) cumulates (SR Melanorite + NR Mafic Norite) formed from a *less evolved* melt, followed by Plag-Opx-(Zir)-(Ilm) cumulates (SR Upper Norite + NR Felsic Norite) and overlying SR and NR Qtz Gabbros formed from progressively fractionated melts, which mixed with overlying more felsic liquids to form overlying SR and NR Granophyres [1]. Collapse and assimilation of crater walls would not produce a reversal in a melt already on the liquidus. Inflow of less evolved melt from another part of the system is more likely. The volume of cumulates produced by the less evolved melt is less than the volume of cumulates produced from the

more evolved melt, so the latter more likely represents inflow from a now-eroded outer part of the multi-ring impact basin (or a dual impact basin) than collapse of the inner peak ring.

References:

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