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TRACE ELEMENT MIGRATION DURING MAGMA MINGLING IN THE COLORADO PROTEROZOIC

GRUEN, Elsa M., Department of Geology, Colorado College, 14 E Cache la Poudre, Colorado Springs, CO 80903, e_gruen@coloradocollege.edu and NOBLETT, Jeffrey B., Geology, Colorado College, 14 E Cache la Poudre, Colorado Springs, CO 80903

Magma mixing models usually assume linear geochemical gradients between end members, but during magma mingling non-linear patterns are evident. Two Proterozoic localities from Colorado illustrate a variety of chemical gradients developed during mingling.

Field relations revealed mingling of lamprophyre and monzogranite along South Hardscrabble Creek in the Wet Mountains (WM) (Staub and Noblett, 1990) and of diabase and quartz syenite near Deckers (D) (Chastain, 1993). Two samples from each locality were analyzed at constant intervals across the contact for 53 major, minor and trace element concentrations using XRF and ICP-MS.

Most major (SiO_2, Fe_2O_3, CaO and MgO) and minor elements (Mn, Ti and P) display non-linear behavior in which weight percents remain relatively constant within each lithology, not varying with distance from the contact, creating a step across the contact. The same pattern is evident for some trace elements (Co, V and Eu). Both LIL and HFSE behave extremely non-linearly. MREE (excluding Eu) and HREE from D exhibit a linear gradient between the two end member lithologies. However, the LREE exhibit an irregular, non-linear pattern, in which elements appear to build up approaching the contact. No REE behave linearly in WM samples.

During magma mingling, therefore, non-linear gradients are common between lithologies. Laboratory experiments have ascribed the physical process of mingling to viscosity, density and thermal contrasts (Snyder and others, 1997). This physical boundary could prevent element migration, creating elevated concentrations at the contact. Non-linear chemical gradients could also be a function of availability of mineral sites for specific elements. These observations also suggest that non-linearity should be expected during incomplete magma mixing and not be used to reject mixing models.

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