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Strontium and oxygen isotopic evidence for strike/slip movement of accreted terranes in the Idaho Batholith

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Abstract

The oxygen and strontium isotope compositions of granitic rocks of the Idaho Batholith provide insight into the magma source, assimilation processes, and nature of the suture zone between the Precambrian craton and accreted arc terranes. Granitic rocks of the Idaho Batholith intrude basement rocks of different age: Triassic/Jurassic accreted terranes to the west of the Salmon River suture zone and the Precambrian craton to the east. The age difference in the host rocks is reflected in the abrupt increase in the initial $^{87}Sr/^{86}Sr$ ratios of granitic rocks in the batholith across the previously defined 0.706 line. Initial $^{87}Sr/^{86}Sr$ ratios of granitic rocks along Slate Creek on the western edge of the batholith jump from less than 0.704 to greater than 0.707 along an approximately 700 m transect normal to the Salmon River suture. Initial $^{87}Sr/^{86}Sr$ ratios along the Slate Creek transect do not identify a transition zone between accreted arcs and the craton and suggest a unique tectonic history during or after suturing that is not documented along other transects on the west side of the Idaho Batholith. The lack of transition zone along Slate Creek may be a primary structure due to transcurrent/transpressional movement rather than by contractional thrust faulting during suturing or be the result of post-imbrication modification.

Keywords: Idaho Batholith; Oxygen isotope; Sr isotope; Zircon; 0.706 line

1. Introduction

First-order constraints on the source materials of magmas can be provided with oxygen and Sr isotope compositions, each of which is sensitive to distinct crustal and mantle reservoirs. Oxygen isotope compositions of magmas are sensitive to the incorporation of material formed by low-temperature, surficial processes (i.e., sediments, hydrothermally altered rocks) and are insensitive to the age of source regions. Strontium isotopes, in contrast, are sensitive to both the age of potential source materials as well as lithology, where, for example, Rb-rich shales would have highly radiogenic Sr isotope compositions, and Rb-poor mafic crust of the same age would be relatively non-radiogenic.

Previous strontium and oxygen isotope studies have identified the presence of a crustal boundary, the Salmon River suture zone, on the western side of the Idaho Batholith (Fig. 1) (e.g. Fleck and Criss, 1985; e.g. Criss and Fleck, 1987; Fleck, 1990; Leeman et al., 1992; Manduca et al., 1992). Suturing between the craton and accreted terranes occurred at approximately 128–118 Ma (Lund and Snee, 1988; Getty et al., 1993). The suture is coincident with the later western Idaho shear

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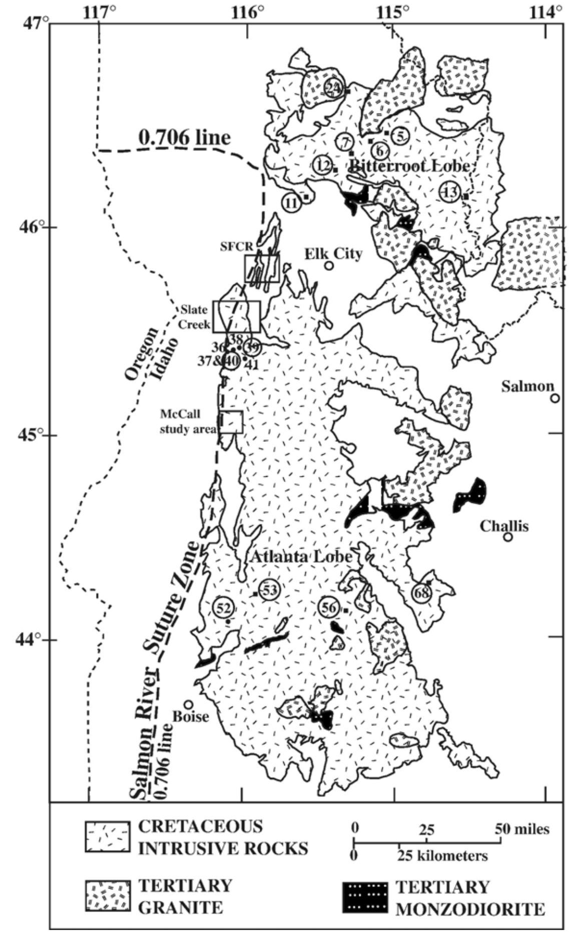

Fig. 1. Simplified geologic map of the Idaho Batholith (after Bennett and Knowles, 1985) indicating sample localities. All sample locality numbers on this map have the prefix 98IB-. Fig. 2 shows localities of samples with the prefix 01IB-. Sample numbers in circles indicate zircon sample locations. Transects made across the Salmon River suture zone are labeled as the Slate Creek transect, South Fork of the Clearwater River (SFCR), and the McCall area. The SFCR is the location of samples from Fleck and Criss (1985). The McCall area is the location of samples from Manduca et al. (1992). Slate Creek is the area of this study and enlarged in Fig. 2. The Salmon River suture zone is coincident with the younger western Idaho shear zone and the 0.706 line.

zone (WISZ) that is associated with tectonic activity as old as 110 Ma continuing through 88 Ma (Lund and Snee, 1988). Shear indicators such as structural fabrics, fold vergence, and displacement on faults suggest right-lateral transpression for accretion along the Salmon River suture in the Slate Creek area (Lund and Snee, 1988). East–west compressive deformation and dextral transpression have also been documented along the batholith margin either during suturing or later shearing (Manduca et al., 1993; McClelland et al., 2000).

Cretaceous granitic rocks of the batholith intruded both sides of the Salmon River suture as well as the western Idaho shear zone itself. The isotopic compositions of granitic rocks that intruded east of the boundary indicate mixing of Phanerozoic juvenile arc and Precambrian crustal sources such as metasediments or orthogneisses. The isotopic compositions of granitic rocks on the west side of the crustal boundary are interpreted to represent magmas that ascended through a juvenile volcanic arc terrane (Leeman et al., 1992; Manduca et al., 1992).

Magmas within the suture zone record the transition from accreted terrane to cratonic basement rocks as represented by increased initial $^{87}Sr/^{86}Sr$ ratios and $\delta^{18}O$ values eastward (Fleck and Criss, 1985; Criss and Fleck, 1987; Fleck, 1990; Leeman et al., 1992; Manduca et al., 1992). Interpretations of isotopic and structural data from the Salmon River suture zone suggest a sub-vertical terrane boundary that includes a transition zone containing imbricated oceanic and continental lithospheric mantle (Leeman et al., 1992; McClelland et al., 2000).

This study examines the Sr and O isotope geochemistry of granitic plutons along a transect across the Salmon River suture zone along Slate Creek (latitude approximately 45°38′) (Figs. 1 and 2) to investigate the geometry of the suture. The initial $^{87}Sr/^{86}Sr$ ratios along the Slate Creek transect do not identify a transition zone between accreted arcs and the craton. The lack of transition zone suggests either no significant imbrication of the continental and oceanic lithosphere at mid-crustal levels and/or a lack of thrusting during suturing and later shearing events along the western side of the Idaho Batholith. Geochemical data from the Slate Creek transect across the Salmon River suture zone document a very different geologic history in this regard than comparable transects to the north and south along strike of the crustal boundary.

2. Regional geology

The Idaho Batholith consists of mesozonal granitic rocks of both Cretaceous and Tertiary age (Vallier and Brooks, 1987). The southern, and larger, portion of the batholith is defined as the Atlanta lobe (25,000 km^2), whereas the northern portion is defined as the Bitterroot lobe (14,000 km^2) (Fig. 1). The emplacement of the Idaho Batholith spans a significant range in ages, generally from 100 to 54 Ma, and many of the mesozonal intrusions contain zircons with inherited cores of Proterozoic age (Armstrong et al., 1977; Chase et al., 1978; Bickford et al., 1981; Chase et al., 1983; Shuster and Bickford, 1985; Lund and Snee, 1988; Toth and Stacey,