ABSTRACT

Delineation of a Mesoproterozoic Magmatic Arc in the Llano Uplift, Central Texas: Evidence from Nd Isotopes

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The Llano uplift of central Texas represents a metamorphic core containing the imbrication of three distinct lithotectonic units that include, from structurally highest to lowest and from south to north, the Coal Creek (CCD), Packsaddle (PSD), and Valley Spring (VSD) domains. Parts of the VSD possibly represent juvenile crustal additions to the southern margin of the North American craton and may be an extension of the Granite-Rhyolite terrane. The PSD represents an intensely deformed supracrustal sequence that was proximal to the VSD, because both domains were intruded by an apparently cogenetic suite of granitoids. The CCD consists of a weakly foliated igneous suite dominated by compositions ranging from tonalite to granodiorite that intrudes older gneisses. The northern boundary of the CCD is marked by the Sandy Creek shear zone (SCSZ), a kilometer-scale mylonite zone containing granites and amphibolites with a pervasive NW to NE trending fabric that dips to the S. A striking paradox is apparent when comparing Sm-Nd isotopic results from the CCD with data from the SCSZ and exposures to the north. The more mafic lithologic assemblage of the CCD has a more evolved initial ε_{Nd} signature than the more compositionally evolved granitic rocks to the north that possess a juvenile ε_{Nd} signature.

Twenty-seven Sm-Nd analyses from this study were combined with published data from Patchett and Ruiz (1989). The combined data set defines fundamental differences between the CCD and the rest of the uplift. Epsilon Nd values at the time of crystallization (initial ε_{Nd}) from the CCD range from +1.2 to +4.1 with depleted mantle ages ranging from 1344 to 1679 Ma. Exposures to the north have a more juvenile initial ε_{Nd} signature that ranges from +2.4 to +6.1 with depleted mantle ages ranging from 1177 to 1545 Ma. The granitoid rocks of the SCSZ yielded the most juvenile ε_{Nd} signature found thus far in the uplift. The southern margin of the SCSZ represents the northern extent of the CCD isotopic signature. The more evolved isotopic signature of CCD implies that its petrogenesis involves an older crustal component. The origin of this older crustal component remains elusive; however, its absence from the other rocks of the uplift suggests that the CCD evolved separately from the uplift.

All of the late granitic intrusive rocks have a juvenile ε_{Nd} signature indicating the involvement of a depleted mantle source. The granites that intrude the CCD commonly have a more evolved ε_{Nd} signature, indicating that the granite melts incorporated portions of the country rock.

The mylonitic fabric of the SCSZ is parallel to the weak foliation exhibited within the CCD. Both fabrics appear to have been formed during the same event (D2: the first common event); however, the different lithologies of the two areas resulted in distinctly different responses to deformation. Analysis of the fabrics in the SCSZ has revealed a thrust sense of shear with top-to-the-north movement. An extensional crenulation cleavage cuts the D2 mylonitic fabric, suggesting that down-to-the-south extension followed contractional deformation.

Based upon the isotopic criteria and field evidence, the southern margin of the SCSZ represents a fundamental lithologic, structural, and isotopic boundary between the CCD and the rest of the uplift. The CCD evolved separately from the Llano uplift and its accretion is thought to have occurred along the SCSZ, when the magmatic arc overrode the southern margin of the North American craton during continental orogenesis.