Untying the Kibaran knot: A reassessment of Mesoproterozoic correlations in southern Africa based on SHRIMP U-Pb data from the Irumide belt

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ABSTRACT

The Irumide belt is part of a network of late Mesoproterozoic Kibaran-age orogens in south-central Africa. Sensitive high-resolution ion microprobe (SHRIMP) U-Pb zircon ages for gneisses, migmatites, and granitoids indicate that peak Irumide metamorphism was ca. 1020 Ma and that this was associated with widespread granitic magmatism at 1050–950 Ma. Pre-Irumide protoliths are dominated by 1650–1519 Ma granitic gneisses. These data provide the first robust constraint on the timing of Irumide tectonism and show that previous estimates of ca. 1350 and 1100 Ma are incorrect, thereby negating previously proposed correlations of the Irumide belt with nearby Kibaran-aged tectonism. The correlation between the Irumide belt and Choma-Kalomo block of southern Zambia has had a major influence on models for the tectonic assembly of southern Africa because it required that the intervening Neoproterozoic Zambezi belt was intracratonic and associated with minimal horizontal displacements. Our data indicate that both terranes have distinct histories, consistent with lithologic and metamorphic evidence of Neoproterozoic ocean closure along the Zambezi belt. This implies that the Kalahari and Congo cratons assembled during the Neoproterozoic and not during Kibaran-age tectonism, as previously believed. This new outlook on regional African tectonics supports a configuration of the Rodinia supercontinent that places the Congo craton well away from the Kalahari craton ca. 1000 Ma.

Keywords: Kibaran orogeny, correlation, southern Africa, Mesoproterozoic, SHRIMP data, Zambia.

INTRODUCTION

The use of relative structural timing and isotope geochronology as means of correlating Precambrian orogenic belts and testing the role of global drift in continental assembly was first proposed by Holmes (1951), using south-central Africa as an example. Subsequent work in this region defined a network of Paleoproterozoic to Neoproterozoic orogenic belts (Cahen et al., 1984) that overprinted the margins of older cratons (Fig. 1) and are commonly grouped into three orogenic cycles (Kröner, 1977) known as the Eburnian (2200–1800 Ma), Kibaran (1350–950 Ma), and Pan-African (800–500 Ma). Although some workers have interpreted all of these belts in terms of plate tectonics and ocean closure (Burke and Dewey, 1972), others emphasized that the older belts occur on both sides of younger crosscutting belts with no apparent offset, a spatial relationship more consistent with ensialic rejuvenation (Kröner, 1977; Shackleton, 1973).

Perhaps the best known of these crosscutting relationships is that between the Irumide and Zambezi belts (Fig. 1). The Zambezi belt is part of an east-west–trending zone of Neoproterozoic tectonism that extends southwestward into the Damara orogen. It is associated with eclogite relics, reworking of older basement blocks including possible island arc and ophiolite terranes, and significant north-south shortening (Dirks and Sithole, 1999; Goscombe et al., 2000; Oliver et al., 1998). The northeast-trending Irumide belt is widely believed to continue along strike across the Zambezi belt, where it is exposed as the Choma-Kalomo block (Hanson et al., 1988; Shackleton, 1973). Preliminary age data confirmed that both terranes developed during the Mesoproterozoic (Hanson et al., 1988) and both are considered part of a single Kibaran orogen. This correlation precludes the closure of a large Neoproterozoic ocean basin along the Zambezi belt and requires that the Kaapvaal-Zimbabwe and Congo cratons were juxtaposed before or during Irumide tectonism.

In this paper we present new sensitive high-resolution ion microprobe (SHRIMP) U-Pb zircon ages from the Irumide belt and demonstrate that previous age estimates of Irumide tectonism are incorrect. We argue that there is no isotopic evidence for any Mesoproterozoic correlation across the Zambezi belt, making it likely that the major cratons of southern Africa did not assemble until the Neoproterozoic.

IRUMIDE BELT

The Irumide belt of Zambia preserves an increasing intensity of Mesoproterozoic tectonism from its northwestern foreland, where undeformed quartzite and pelite of the Muva Supergroup unconformably overlie 2000–1800 Ma granites and volcanics of the Bangweulu block, through a fold-and-thrust belt into an internal zone, characterized by syntectonic to late tectonic plutons, amphibolite facies gneisses, and migmatites (Andersen and Unrug, 1984; Daly, 1986a, 1986b; Daly and Unrug, 1982; Drysdall et al., 1972). The southeastern margin of the belt is not preserved; the Irumide gneisses are progressively overprinted in southeastern Zambia and Malawi by high-grade Neoproterozoic structures of the Zambezi and Mozambique belts. The Irumide belt is truncated to the northeast by Neoproterozoic shear zones along the Ubendian belt.

Lithologies within the internal zone of the orogen include the metasedimentary Manshya River Group and a range of granitoid units (Fig. 2). In the northeastern part of the belt, the granites and orthogneisses are classified as pre-, syn- or late-tectonic, depending on the intensity of ductile fabrics observed in the field. This subdivision was supported by limited Rb-Sr data that identified ca. 1800 Ma gneissic basement, correlated with the Bangweulu block, ca. 1400 Ma pretectonic to early tectonic foliated granitoids collectively called the Mutangoshi gneissic granite, and ca. 1000 Ma posttectonic plutons comprising the Bemba batholith and Chilubanama granite (Daly, 1986b) (Fig. 3). Despite the fact that textural differences and contrasting field relationships allow such subdivision in the southwest, the