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Laurentia-Kalahari Collision and the Assembly of Rodinia

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ABSTRACT

The Llano Orogenic Belt along the present southern margin of Laurentia, regarded as continuation of the Grenvillian Orogen along the eastern Laurentian margin and exposed in basement uplifts in central and western Texas, records an ~300-m.yr. history of orogenesis culminating in arc-continent and continent-continent collision between ~1150 and 1120 Ma and continuing until ~980 Ma. The shape of the orogen and kinematics of the contractional deformation along the belt, together with the high-P metamorphic conditions attained, indicate that a previously unidentified craton served as an indentor. It is paleomagnetically acceptable for the Kalahari Craton of southern Africa to have been opposed to this margin and within ~1500 km of present-day central Texas at ~1100 Ma. Moreover, the Kalahari Craton is the correct size, and the structural and metamorphic evolution of the 1200–950 Ma Namaqua-Natal Orogenic Belt that wraps around its present southern margin is compatible with that craton having been the indentor. The ocean basin that closed between the Laurentia and Kalahari Cratons would have been comparable to the present Pacific, with island arc/terrane accretion occurring during the Mesoproterozoic along opposing active convergent margins. The coeval 1.1 Ga Keeweenawan and Umkondo magmatic provinces of Laurentia and Kalahari, respectively, are associated with rifts at a high angle to the Llano and Namaqua Orogens. The rifts are interpreted as the result of collision-generated extensional stresses within the two cratons. The voluminous mafic igneous rocks in both provinces, however, may reflect contemporaneous plume activity. Our reconstruction for 1.1 Ga provides a testable model for the Llano Orogenic Belt of Texas and the Namaqua Orogenic Belt of southwestern Africa as opposite sides of a Himalayan-type collisional orogen, with the Natal Belt of southeastern Africa and the originally continuous Maudheim Belt of East Antarctica as a related Indonesian-type ocean-continent convergence zone. This reconstruction leads to a refinement of the paleogeography of Rodinia, with the Kalahari Craton in a position isolated from both the East Antarctic and Rio de la Plata Cratons by oceanic lithosphere. It also provides the first model for the assembly of that hypothetical early Neoproterozoic supercontinent. At least four separate cratonic entities appear to have collided along three discrete segments of the apparently anastomosing global network of "Grenvillian" orogens: the type-Grenville Belt of eastern North America and counterparts in South America, the Llano-Namaqua Belt, and the Eastern Ghats-Albany/Fraser Belt of India-East Antarctica and Australia. Over the remarkably short interval of ~200 m.yr., this first-order composite collisional event resulted in the amalgamation of most of Earth's continental lithosphere and defined the close of the Mesoproterozoic Era.