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TECTONIC SETTING OF THE KOLAR SCHIST BELT, KARNATAKA, INDIA;

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The Archean Kolar Schist Belt has the key features of a suture zone, i.e. the juxtaposition of terranes of distinctly different gological histories. Based on geology, trace element geochemistry, initial, radiogenic-isotope ratios and geochronology, we recognize at least four different terranes consisting dominantly of: 1) felsic gneisses to the east of the belt, 2) felsic gneisses to the west of the belt, 3) amphibolites in the west central part of the belt, and 4) amphibolites in the eastern part of the belt (Fig. 1).

West of the belt, granodioritic gneisses were emplaced at 2632±8 Ma, 2613±10 and 2553±3 Ma and metamorphosed at 2553±2 Ma. These gneisses have inherited zircons from an older basement at least 3200 Ma old. The Pb, Sr, and Nd isotopes have a continental signature also suggest that a ca. 3200 Ma, or older, basement contaminated the magmas parental to the western gneisses (1).

East of the belt, the gneisses were emplaced at 2532±3 Ma and cooled or were metamorphosed at 2521±2 Ma. The Pb, Sr and Nd isotope data for these gneisses have a mantle signature. These isotopic and age differences suggest that the two gneiss terranes had separate histories until some time after 2521 Ma (1).

Within the schist belt the komatiitic amphibolites to the east are dominantly light REE enriched and those in the west-central part are dominantly light REE depleted and each has a distinctly different Pb isotope character (2,3). The west-central, komatiitic amphibolites give a Sm-Nd age of 2690±140 Ma and the west-central tholeiitic amphibolites give a Pb-Pb isochron age of 2733±155 Ma(2), suggesting that some of the amphibolites may be older than the 2530 to 2630 Ma gneisses to the east or west of the belt.

Surprisingly, the Pb isotope ratios for the tholeiitic amphibolites from the west-central part of the belt are significantly different from the Pb isotope ratios for interlayered komatiitic amphibolites, suggesting that the parental magmas of the tholeiitic amphibolites are derived from sources with a quite different U-Pb history than the parental magmas of the komatiitic amphibolites (2). Rajamani et al.(3,4) suggest that while the west central komatiites are derived by melting at pressures of about 50 Kb from a mantle source with an Fe/Mg ratio somewhat greater than that for pyrolite, the tholeiites are derived by melting at pressures less than 25 Kb from a source with a much higher Fe/Mg ratio than that for the komatiites.

The long-lived depleted light REE depleted character of the west-central komatiitic amphibolites (2) suggests that if there were an Archean MORB source, these komatiitic amphibolites are candidates for derivation from such a source. The tholeiitic and komatiitic amphibolites may be tectonically interlayered. Or, the tholeiites may have been intrusions. If, however, they were developed at the same time and place, we would suggest an asthenospheric source for the komatiitic amphibolites and a subcontinental lithospheric source for the tholeiites.

The eastern amphibolites have not been dated, but their Nd and Pb isotope character suggests an age of ca. 2700 Ma(2). The light REE enrichment and distinctly different Pb isotope character of the eastern amphibolites, suggest that they were derived from a mantle source with a REE and U-Pb history quite different from that of the west-central amphibolites. This would also suggest that they formed in different settings on the surface of the earth.

Fig. 2 shows in block diagrams the timing and development of the Kolar Schist Belt. At about 2700 Ma, the parental rocks of the eastern and west-central parts of the schist belt developed in potentially widely separated environments. The western terrane consisted only of the 3200 Ma or older basement. The eastern terrane did not exist. By 2530 each of the terranes had developed their major lithologic character, but were probably not yet juxtaposed. By 2420 Ma, a time of major shearing and metamorphism (1), the different terranes were juxtaposed.

A plate tectonic and uniformitarian model could explain many of the features of the Kolar Schist Belt and surrounding gneisses. The parents for the west-central komatiitic amphibolites may have been the Archean equivalent of modern mid-ocean ridge or back-arc-basin basalts derived from a long-lived, incompatible-element-depleted mantle source. Ocean ridge melts may have been komatiites due to the higher heat budget during the Archean. If the parents of the west-central, tholeiitic amphibolites formed at the same time and place as the parents of the komatiitic amphibolites, a setting more like that of a back-arc basin would be required in which a long-lived, perhaps subcontinental lithosphere could be the source for the parents of the tholeiitic amphibolites and the underlying aesthenosphere could be the source for the parents of the komatiites. If the komatiites and tholeiites were interlayered tectonically or either are intruding the other, then the tholeiitic and komatiitic parents could have formed in different locations and at different times. The parents for the eastern komatiitic amphibolites could have been the Archean equivalent of modern ocean island or island arc basalts.

The character of the plutonic rocks of the western gneisses and their setting upon an older basement, is compatible with the development of a magmatic arc on the edge of a continent. We do not have an explanation for the tectonic setting for the eastern gneisses, which are typical of many Archean granitoid rocks in that they have mantle isotope signatures, but are geochemically quite evolved.

We would suggest that: 1) the multiple phases of folding, resulting in refolded isoclinal folds in the iron-formation due principally to E-W subhorizontal shearing followed by longitudinal shortening (5), 2) the late N-S left lateral shearing found in all rocks, and 3) the disparate geologic terranes are features very similar to those geologic features found in the accretionary terranes of western North America (6).

(1) E.J. Krogstad et al., this volume.
(2) S. Balakrishnan et al., this volume.
(3) V. Rajamani et al., 1985, J. Petrol. 26, 92-123.
(4) V. Rajamani et al., in prep.
(5) D.K. Mukhopadhyay, this volume.
(6) J.B. Saleeby, 1983, Ann. Rev. Earth Planet. Sci. 11, 45-73.

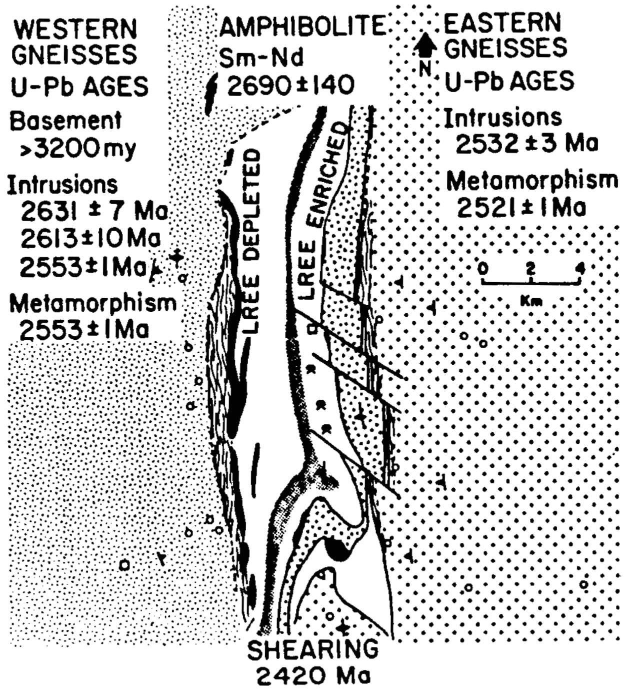

Fig. 1. Geological sketch map of the central part of the Kolar Schist Belt. The basement age for the western gneisses is based on Pb/Pb ages for the cores of zircons from and Pb and Nd isotope data for the ca. 2600 Ma western gneisses. Intrusive and metamorphic ages for the gneisses are the U-Pb ages for zircon and sphene respectively. The age of shearing is based on an Ar/Ar plateau age for muscovite developed in the shear zone. The Sm/Nd isochron age is for the western komatiitic amphibolites.

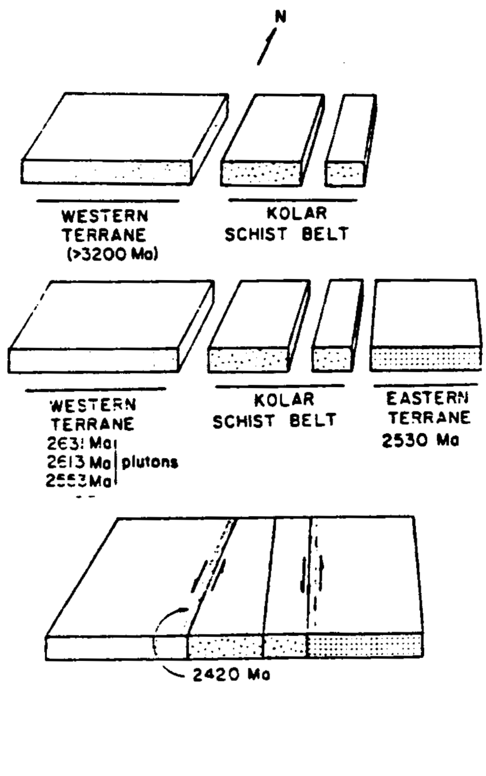

Fig. 2. Block diagram showing the crustal evolution in the Kolar area.