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THE KOLAR SCHIST BELT: A POSSIBLE ARCHEAN SUTURE ZONE

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The Kolar Schist Belt in the Karnataka craton, south India, is a 4 to 20 km by 80 km long, N-S trending Archean supracrustal belt dominated by mafic metavolcanics. The schist belt is surrounded on both sides by granodioritic gneisses collectively known as the Peninsular Gneiss. Our work has shown that the Kolar Schist Belt and the surrounding gneisses include major discontinuities in age, structural style, and composition. These discontinuities are defined by the schist belt itself.

The results reported here are based on our Rb-Sr, Sm-Nd, and Pb-Pb whole rock isotope data; U-Pb dating of zircon and sphene; major and trace element (including REE) analyses; and field observations.

The schist belt is broadly synformal, but is complexly refolded into basin and dome structures (D. Mukhopadyay, personal communication). The first period involved N-S trending isoclinal recumbant folds during E-W compression. These folds were refolded into tight, upright folds along E-W trending axes. This sequence is broadly similar to those seen in other schist belts in the western part of the Karnataka craton.

Contacts between the Peninsular Gneiss and the margins of the belt have long been thought to represent an erosional unconformity. However, our recent field work indicates that the rocks at the contacts are physically interleaved by left lateral shearing. Due to this shearing the adjoining gneisses have been converted to quartz-muscovite schists, which were previously interpreted to be metasedimentary rocks.

The gneisses east of the schist belt are relatively homogeneous, granodioritic gneisses which were folded prior to intrusion of minor felsic bodies. Folds have not yet been defined in these gneisses, but a strong foliation was developed which strikes NNE and dips steeply to the west, suggesting horizontal compression.

The gneisses west of the schist belt show a much more complex, earlier history than that of the eastern gneisses. The granodioritic Dod Gneiss is the earliest unit on the western side of the schist belt. This rock was subjected to a period of deformation shown by an early foliation seen in some less-strained exposures. Subsequently, the Dod Gneiss was intruded by the leucocratic, granodioritic Dosa Gneiss and the granodioritic Patna Granite.

Following the intrusion of the Dosa Gneiss, the terrane to the west of the schist belt was subjected to a period of horizontal compression producing tight to isoclinal, W overturned folds with gently N or S plunging axes. The strong NNE axial planar foliation produced by this deformation is cut by the later N-S shears along the western margin of the schist belt.

The gneisses on the east and west side of the belt have been dated using U-Pb ages for small populations of abraded zircons and abraded single zircons as well as sphene. These zircons commonly give concordant ages, in which case the small populations of zircons (ca. 100 micrograms) have analytical uncertainties of less than 1 Ma. and the single zircons have uncertainties of about 5 Ma.

Gneisses east of the belt were intruded at 2529±1 Ma based on U-Pb ages for zircon. This age is consistent with the Rb-Sr and Pb/Pb whole rock isochron ages. The isochrons have a mantle-like initial ratio for Sr (87/86=0.7013) and mu=8 for the Pb data. These values suggest that the gneisses were not derived from a much older continental crust. U-Pb ages for metamorphic sphene are 2520 ±1 Ma suggesting that the gneisses were metamorphosed to at least amphibolite grade at that time.

West of the belt, based on U-Pb ages for zircon, the Dod Gneiss was emplaced at 2610±5 Ma, the Dosa Gneiss was intruded at 2550±10 Ma and the Patna Granite at 2551±1 Ma. The time of metamorphism based on the U-Pb ages for sphene from the Dod Gneiss is 2551±1 Ma. Rb-Sr and Pb/Pb whole rock data suggest that the gneisses were variably contaminated by an older basement. U-Pb ages for some of the single zircon cores from the Dod Gneiss and later aplitic dikes indicate a zircon component was inherited from this basement, which has a minimum age of 3200 Ma. The basement, which has not yet been clearly identified in the field, seems to include quite evolved felsic rocks.

In the Kolar Schist Belt there are two suites of komatiitic and tholeiitic amphibolites. Both the komatiitic and tholeiitic amphibolites on the eastern side are light REE enriched, and almost all of the komatiitic and tholeiitic amphibolites in the west-central part of the belt are lightest REE depleted. The preservation of rare pillow structures and the association of the amphibolites with iron formation suggest that the amphibolites were formed under submarine conditions. The grade of metamorphism is amphibolite facies.

Rajamani et al. (1) concluded that the komatiitic amphibolites from both the east and west central part of the belt were derived by 10 to 25% melting at depths greater than 80 km and at temperatures greater than 1500^{o}C in a mantle with an FeO/MgO ratio greater than that of pyrolite. Other models proposed for the generation of komatiites generally require larger percentages of melting to generate the high MgO abundances.

Rajamani et al. (1 and in preparation) suggest that the tholeiites appear to have been derived by melting at shallower levels than the komatiites and derived from sources which were highly variable in their FeO/MgO ratios, generally with FeO/MgO ratios much greater than that for the sources for the komatiites. The key arguments are that: the tholeiites are very iron-enriched compared to the field for potential melts of pyrolite at pressures less than 25 kb on an olivine saturation surface; and while the incompatible elements show similar ratios in the komatiites and tholeiites for each suite, the expected correlations between major and trace elements for differentiation from komatiites or melting of sources similar to those of komatiites are not found.

Sm-Nd data for komatiites from both sides of the belt lie with large variations about a 2900 Ma isochron. It is not clear why the data lie about a 2900 Ma isochron. Is this the age of these amphibolites? If this is so, they are much older than the igneous felsic rocks on either side of the belt which are 2500 to 2600 Ma. Or, is this the time when the sources became variably light REE enriched and depleted? Some of the variation in the Sm/Nd ratios is clearly a function of melting processes in which garnet was left in the residue. Perhaps the variability in the data about the reference line reflects a number of reasons such as: variable times of light REE depletion and enrichment of their mantle sources; as well as the possible effects of crustal contamination or metamorphic alteration.

Even though the ages of the units making up the Kolar Schist Belt are poorly constrained, the sources of the amphibolites so far analyzed had long-term histories of LREE depletion (epsilon Nd of +2 to +8 for an age of 2900 m.y.) relative to other Archean mafic rocks which commonly have epsilon Nd equal to about $+2.0 \pm 2.0$.

The Kolar Schist Belt represents a N-S trending discontinuity in the structures, lithologies, and emplacement and metamorphic ages of late Archean gneisses. The suggestion of a much older basement on the west side of the belt is not seen on the east. Within the schist belt amphibolites from each side have distinctly different chemical characteristics, suggesting different sources at similar mantle depths. These amphibolites were probably not part of a single volcanic sequence, but may have formed about the same time in two completely different settings. Could the amphibolites with depleted light REE patterns represent Archean ocean floor volcanics which are derived from a mantle source with a long term depletion of the light REE? Why are the amphibolites giving an age which may be older than the exposed gneisses immediately on either side of the belt? These results suggest that it is necessary to seriously consider whether the Kolar Schist Belt may be a suture between two late Archean continental terranes.

REFERENCES

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