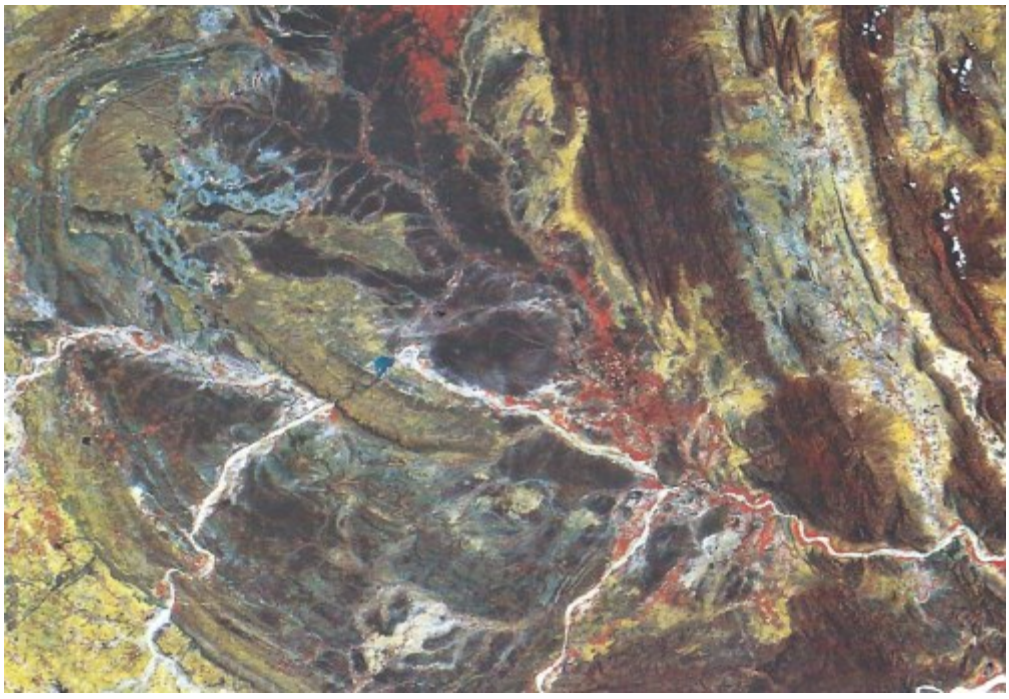
Sedimentology and stratigraphy

Some cunning radiometric dating in the Cuddapah Basin (*November 2015*)

At the end of the 1970's I was invited by the Deputy Director of the Geological Survey of India (Southern Region) to participate in the *Great Postal Symposium on the Cuddapah Basin*: a sort of harbinger of the Internet and Skype, but using snail-mail. Feeling pretty honoured and most intrigued I accepted; not that I knew the first thing about the subject. A regular stream of foolscap mimeographed contributions kept me nipping out of my office to check my pigeon hole for about 6 months. I learned a lot, but felt unable to comment. Four years on I was taken across the Cuddapah Basin in southern Andhra Pradesh by my first research student – a budding moto-cross driver with a morbid fear of bullock carts – en route from the Archaean low-grade greenstone-granite terrains of Karnataka for a peek at the fabled charnockites near Chennai (then Madras). A bit of a round-about route but spurred by my memories of the Great Postal Symposium. Sadly, the detour was marred for me by a severe case of sciatica brought on by manic driving, the state of the trans-Cuddapah highway and a misplaced gamma-globulin shot to ward off several varieties of hepatitis: I mainly blamed the nurse who demanded that I drop my drawers and bravely take the huge needle in a buttock – they do these things more humanely these days. Anyhow, apart from seeing many dusty villages build of slates perfect enough to make a full-size snooker table, my mind was elsewhere and I have long regretted that.



Landsat image mosaic showing part of the Cuddapah Basin.

Hosting possibly the world's only diamondiferous Precambrian conglomerate, the Cuddapah Basin contains a 5 km thickness of diverse sedimentary strata, but no tangible fossils. It rests unconformably on the Archaean greenstone-granite terrain of the Dharwar Craton and so is Proterozoic in age; an Eon that spans 2 billion years. The middle of the lowest sedimentary formations (the Papaghni and Chitravati Groups) contains volcanic rocks dated at ~1.9 Ga;

another group is cut by a ~1.5 Ga granite, and the youngest dateable event is the emplacement of 1.1 Ga kimberlites that sourced the diamonds in the conglomerate. Until recently the stratigraphy has been known in some detail, but how to partition it in Proterozoic time is barely conceivable with just three dates in the middle parts that span 800 Ma. All that can be said about the base of the Cuddapah sediments is that they are younger than the 3.1 to 2.6 Ga Archaean rocks beneath. Since the uppermost beds are truncated by a huge thrust system that shoved deep crustal granulites over them their minimum age is equally vague.

Structurally, the Basin began to form on a stable continent underpinned by the Dharwar Craton, but when that collided with Enderbyland in Antarctica, as part of the accretion of the Gondwana supercontinent, sedimentation may have been in an entirely different setting. Indeed, some of the sediments have been carried over the undisturbed part of the basin by a major thrust system. To explore both sedimentary and tectonic evolution Australian, Indian and Canadian geoscientists combined to sample and radiometrically date the entire pile (Collins, A.S. and 13 others 2015. Detrital mineral age, radiogenic isotopic stratigraphy and tectonic significance of the Cuddapah Basin, India. *Gondwana Research*, v. **28**, p. 1294-1309; DOI: 10.1016/j.gr.2014.10.013). By precisely dating detrital micas and zircons from the sediments the team was able to check the source region of sedimentary grains as well as to establish a maximum age for each major stratigraphic unit. This helped establish a 3-part sedimentary and tectonic history. The earliest sediments came from the cratonic area to the west, but there are signs that collisional orogeny between 1590 and 1659 Ma produced a new sedimentary source in metamorphic rocks forming to the east. A return to westward provenance marked the youngest sedimentary setting. This enabled the team to suggest a dual evolution of the Basin, first as an extensional rift opening at the east of what is now the Dharwar craton followed by collisional orogeny that transformed the setting to that of a foreland basin, analogous to the Molasse basin in front of the Alps during Cenozoic times, ending with tectonic inversion when extension changed to compression and thrusting.

But to what extent did the work improve the age subdivision of the Cuddapah Basin? Apparently very little, which may be down to a problem with dating detrital minerals. If magmatic and metamorphic evolution was continuous in the areas from which sediments moved, then the youngest grain is a good guide to the maximum age of the sediment being analysed. The more strata are analysed in this way the better the detail of sedimentary timing. But two tectonic terrains are unlikely to produce zircons time and time again during a period approaching a billion years. The data indicate only 3 or 4 episodes of 'zirconogenesis' in the sedimentary hinterlands, between about 900 to 1940 Ma. Apart from helping correlate sedimentary formations that were previously deemed stratigraphically different – which did help in tectonically unravelling this complex major feature – several hundred isotopic analyses of zircons and micas have give much the same timing as was known already in more precise terms from stratigraphy assisted by a few dozen conventional radiometric dates.