# DISCUSSION

## Comment

(Comment on the paper, '**A Reappraisal of an Archaean carbonatite from the Nellore schist belt, south India**'. By Anil Kumar, R. Srinivasan, K. Gopalan and D. J. Patil, published in the Journal of the Geological Society of India, Vol. 40, No. 2, 1992, pp. 169-174).

I ennumerate here below some vital points on these carbonate on which I disagree with the opinions of the authors of the paper under comment.

1) The authors of the paper state that the carbonate rock occurs within the Nellore schist belt, which is referrable to the Sargurs of Karnataka craton (page 169, para 1, lines 25 and 26), and this is absolutely wrong. The Nellore schist belt is divisible into two stratigraphic entities, a lower high-grade schistose complex with meta-pelites, meta-psammites and meta-amphibolites which registers a regional metamorphic grade of upper amphibolite facies and are regionally migmatised as well and these are considered to be the equivalents of the Sargur type of lithologies in Karnataka. Overlying this high-grade complex is the complex of felsic and basic metavolcanics and the associated metasedimentaries registering an overall greenschist facies of metamorphism, referred to as the Vinjamur greenstone belt, after the village in the vicinity of which large outcrops of this complex are seen; the contact between the high-grade schistose complex and the overlying greenstone belt is marked by a thrust (Vasudevan *et al.* 1977) and is inferred to be conformable (Vasudevan, 1984).

2) The authors of the paper state that these carbonates occur in close association with metasedimentaries like quartzites and/or mica-schist (*see* page 170, para 2, lines 6 and 7). By and large the carbonates occur in intimate association with felsic metavolcanics, viz., rhyolite-tuff, tuff-lava, dacite-tuff lava, dacite tuff, andesite tuff lava, andesite tuff or rhyolite-porphyry (*see* the geological map of Vasudevan, 1989) and only rarely do we notice them in association with thin schistose layers which are mistaken for sedimentary quartzite or metapelites. These so called metasedimentary beds are of unmappable dimensions and they occur as intercalations between the metavolcanics and the interlayered carbonates and are therefore nothing but volcanic exhalites which had been metamorphosed—a meta tuff.

3) Regarding the authors' description of the carbonates from the Venkatadripalem area (p. 170, para 1, line 1), I would like to state that these do not represent the carbonates but an impure barytic rock (baryte-magnetite-quartz-manganese ore rich part of the layered Archaean barytes of the area) which carries calcite as an accessory mineral; whereas the actual baryto-carbonatite in the Venkatadripalem area lies 200 m west of this locality on the bank of a dry streamlet.

4) When thin sections of Vinjamur carbonatites are examined under microscope the magnetite grains are found to be euhedral, often embaying into adjacent calcite or phlogopite or quartz and this feature cannot be reconciled with a sedimentary carbonate, as the embayed grains represent phenomenon of magmatic corrosion. Further, the authors state that quartz is alien to carbonatite mineralogy which is

again not true (para 1, page 172, line 13), as quartz has been reported to occur in many carbonatites (Heinrich, 1966). In fact many carbonatites are silicified after emplacement by immediately following event of hydrothermalisation and it is silicification that has given rise to banding in some of the carbonatite outcrops of Vinjamur.

5) Lack of well defined zone of fenitisation, depleted of LREE and the absence of alkali rocks *sensu stricto* as a consanguineous member have prompted the authors to name these as sedimentary carbonatites.

Here I would like to point out that the Vinjamur carbonatites are not to be compared to the high temperature intrusive carbonatites of much younger geological epochs; they are low-temperature (baryte enriched) extrusive type (carbonatite tuff-lava/tuff metamorphosed regionally). Many high-level intrusive and extrusive carbonatites (e.g., high level carbonatites in south-east Zambia or the Magnet-Cove, Arkansas, U.S.A. – Bailey, 1990; Heinrich, 1966) are devoid of fenitised horizons and are remotely or not at all related to alkaline magmatism. Therefore, the criteria that the Vinjamur carbonatites are devoid of fenitisation and associated alkaline rocks cannot be held as valid reasons to call these as sedimentary carbonatites.

6) Anil Kumar *et al.* based on some carbon and oxygen isotope data obtained on the Vinjamur samples (some of which may not represent carbonates at all) came to a conclusion that these are not true magmatic carbonates. When one deals with carbon and oxygen isotope data of carbonatites he should first of all check up whether the carbonatites under investigation is of intrusive or extrusive origin, for it is well known that many of the extrusive carbonatite have oxygen and carbon isotope values which are at variance with those of intrusive carbonatites and hence when these values are plotted on a oxygen isotope *vs* carbon isotope diagram, they lie outside the carbonatite field defined by intrusive carbonatites (Vasudevan, 1984; Sheppard and Dawson, 1973: Taylor *et al.* 1973). Examples of carbonatites belonging to this later category are Fort Portal vesicular carbonatite, Uganda; Premier Mine carbonatite, S. Africa; Karimesi carbonatite lava, Tanzania; and Spitskopp carbonatite, Namibia (Taylor *et al.* 1969).

7) The Vinjamur carbonatites are extrusive, being either tuffaceous or lava-like, associated genetically with the felsic metavolcanics with which it shares common chemical traits—namely, both are enriched in Ti, Fe, Ba, Sr and Mn; garnets and tourmaline which are found in the Vinjamur acid metavolcanics are found as ubiquitous minerals in the carbonatites too (Vasudevan, 1984). True, the Vinjamur carbonatites are depleted in LRE and some minor trace elements which are generally found in abundance in typical carbonatites.

This depletion may be due to the effects of more than one period of deformation undergone by these carbonatites or simply an inherent trait of these very ancient carbonatites. Texturally, mineralogically, petrographically and to some extent chemically and isotopically these are true carbonatites of volcanic origin.

Lastly, it may be borne in mind that carbonatites are very enigmatic rocks no two occurrences of which appear to have very similar chemical traits and origin and recently, Bailey (1990) an authority on the carbonatites of Africa has cautioned that we should reject the idea or notion so seductive in geology that carbonatite melts and fluids must be linked to one primary magma or derived by one dominant evolutionary process. He further says 'All options are open (and some yet to be devised, no doubt) – there is still much to learn and at *present every carbonatite should be* seen as a special case'.

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## Reply

Dr. Vasudevan has disagreed with our reinterpretation of the Vinjamur carbonate rocks as only metasedimentary and not igneous. He has raised some points in defence of their igneous origin. Our reply to each one of his points is given below.

1. We considered the Vinjamur carbonate rocks as belonging to high-grade metamorphic complex, as at Venkatadripalem they occur adjacent to the kyanite-quartz-mica schist typical of the Sargur Group. No thrust plane is evident here between the two rock types. Vasudevan and Rao (1975) and Narayanaswami (1975 also considered the crystalline limestones and associated mica schists with kyanite) of Vinjamur area as equivalents of Sargur Group. Even if, as Vasudevan states now (on the basis of his unpublished thesis of 1984), the carbonate rocks belong to the overlying low-grade complex correlatable with the Dharwar Supergroup, we would like to point out that the latter also has abundant carbonate rocks in association with quartzites, metapelites and metavolcanic rocks. The main question, however, is not the stratigraphic status of the Vinjamur carbonate rocks, but whether their origin is igneous or sedimentary.

2. Vasudevan has misquoted us as having stated that the carbonate rocks are associated with only metasedimentary rocks like quartzites and mica schists. In fact we clearly described their association with metasedimentary as well as metavolcanic rocks (*see* Anil Kumar *et al.* 1972, p. 171-172). None of the carbonate rocks we studied from the three occurrences near Vinjamur shows any relict volcanic textures (cf. Keller, 1989). Vasudevan (1977) also has not described any volcanic textures in them earlier. On the other hand, at some places as for example in the outcrop near 50th mile post on the Udayagiri-Kavali road, well preserved bedding planes can be seen in the carbonate rocks. Textural evidence from quartzites shows sutured grains of quartz, rather than recrystallized polyhedra indicating that they are metamorphosed detrital sediments rather than exhalites.

3. Although we have not studied samples from the newly cited outcrop situated 200 m west of the outcrop examined by us and reported earlier by Vasudevan, we recollect from the field notes that in outcrop and in hand specimens, the rocks from this location are similar to the ones near Bandakindapalli characterized in our paper.

4. Morphology of magnetite grains in a metamorphic rock cannot discriminate between volcanic or sedimentary origins of protoliths as even at low metamorphic grades euhedral magnetite growth is common. In thin sections euhedral as well as anhedral magnetites are seen in the Vinjamur carbonate rocks although rarely. The calcitic carbonate rocks (sovites of Vasudevan, 1977) found near Udayagiri road are virtually free of magnetite clots. The discrete grains of quartz in a carbonate matrix showing no metasomatic replacement relationship with the latter indicate that quartz in these carbonate rocks is not formed due to secondary silicification commonly seen in carbonatites.

5. Fenitization is common not only at the contact of the intrusive carbonatites but also at the contact of high level intrusives and extrusives, as exemplified by K-metasomatism at the contact of Rufunsa carbonatites (Bailey, 1990) and Na-metasomatism associated with Oldoinyo Lengai carbonatite volcano (Dawson, 1989). Le Bas (1987) has observed that sovites, dolomitic carbonatites and rarely microsovites show fenitization, whereas alvikites and ferrocarbonatites do not. Calcitic and dolomitic composition of Vinjamur carbonate rocks would have led to fenitization, had they been carbonatites.

6 and 7. As desired by Vasudevan, we have compared the abundances of Nb, Zr (HFS elements) and REEs of the Vinjamur carbonate rocks specifically with that of extrusive carbonatites, as these elements are diagnostic of carbonatites.

It is seen that the abundances of vanadium and HFSE (Nb, Zr and Y) of the Vinjamur carbonate rocks are all well outside the range of extrusive carbonatites also. The abundance levels for these elements are even lower than in the completely recrystallized calcitic ash underlying the lapillistone in Henkenberg, which shows least abundances of these elements (*see* Keller, 1989). Although La content in the Vinjamur carbonate rocks is similar to that in the recrysallized calcitic ash of Henkenberg, the abundance of LREE is totally different in the two rocks. Vinjamur carbonate rocks are strongly depleted in LREE relative to the extrusive carbonatites also.

$\delta^{18}O$ SMOW ratios of +14 to 16‰ even after depletion due to metamorphism in the metacarbonate rocks of Vinjamur is higher than the range of 8 to 11‰ characteristic of extrusive carbonatites. $\delta^{13}C$ ratios of extrusive carbonatites fall in the range of −5.5‰ to −11‰ relative to PDB. There are no reports of values between 0 to −2‰ (*see* Deines, 1989) shown by the Vinjamur carbonate rocks.

Vasudevan has not touched upon the Sr isotopic composition of the Vinjamur carbonate rocks, which we have discussed in our paper as providing the most compelling evidence for their sedimentary origin. In addition to the nonmantle like composition of the Vinjamur carbonates, the wide variation in the initial strontium ratios as observed in the Vinjamur carbonate rocks argues strongly against a common igneous source implied for a carbonatite.

In the light of the foregoing clarifications to each one of Vasudevan's comments, we see no reason to revise our earlier interpretation of the Vinjamur carbonate rocks as only metasedimentary and not meta-igneous.

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