DISCUSSION

Comment on the paper, "**Plate Tectonics or an Expanding Earth**" by Oakley Shields, published in Jour. Geol. Soc. India, v.47, No.4, 1996, pp.399-408.

In the above paper, Shields (1996) has pointed out that while in the model of expanding earth some geological problems are readily solved, plate tectonics, on the other hand, encounters major inconsistencies. Nearly two decades back, when the plate theory was gaining popularity as a revolutionary concept, Muratov (1977) commented that expanding earth hypothesis is largely in accord with the geological evidences and does not at any rate contradict the data on the history of the earth's surface, though lack of a cause of the process was its weakest point. In view of the solid nature of the overall mantle, confirmed by seismic data, arguments can also be raised that convective current capable of driving continents to enormous distance is not compatible in the interior of the earth.

It is reasonable to consider that, be it in plate tectonics or in earth expansion theory, for support of large scale mobilistic phenomena over the crustal surface, the condition of the mantle must be sufficiently fluid. This requirement cannot be fulfilled in plate tectonics, which despite verification of relatively younger ages of the ocean floors, envisages great antiquity of the ocean basins. Emergence of new oceanic crust through the mid- oceanic ridges is an observed fact whereas the concept of subduction, conceived in plate tectonics to account for the unaltered dimension of the globe through the past geological ages, is highly debatable.

In a new expansion based gobal tectonics, the present author (Sen 1984, 1992) has conceived that the primordial earth, which was covered by the sialic crust, was virtually devoid of ocean bodies and, hence, its mantle must have been sufficiently fluid for incorporating the ocean-forming water under ultra-high pressure condition. This concept has been derived from the results of experimental studies on silicate rocks under hydrothermal and high pressure condition confirming depression of melting point of such rocks (Roy and Tuttle, 1956). Further, drawing evidences from tidal phenomenon, the cause of expansion can be attributed to the gravitational pull of planetary bodies which would principally affect the semi fluid terrestrial mantle triggering expansion of the earth. In consequence of such expansion, cracks or mid-oceanic ridges would be formed over the sialic crust through which molten basaltic magma would extrude and spread on both sides giving rise to the phenomenon of sea-floor spreading. With continued expansion, the fragmented parts of the supercontinent would move further away from each other opening and gradually enlarging the ocean basins. The process would evidently be accompanied by widespread volcanic eruption and degassing through the mid-oceanic ridges due to which, besides emergence of ocean water, the mantle itself would eventually assume rigid characteristics when large scale expansion of the planet would be stopped.

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Reply

Here, I will reply to the points raised by Sen. Earth expansionists are currently divided on the subduction issue, some embracing it (*e.g.* H.G. Owen, myself), others opposing it (*e.g.* S.W. Carey, L.S. Myers). If there can be no subduction, what then happened to the MOR's in the North Pacific, the Argo Sea, and the Wharton Basin which produced that seafloor, and how then did palaeoequators in the western Pacific become displaced northward as evident from fossil chert-chalk lines and palaeomagnetism? High similarity of MOR hydrothermal vent faunas for the NE Pacific/Japan/Marianas/Fiji strongly argues for dispersal directly along connecting MOR's prior to their subduction along the North Pacific margin (Tunnicliffe, V. and Fowler, C.M.R., 1996). Geodetic rapid convergence at the Tonga arc, Upper Cretaceous pelagic limestone of low latitude origin in coastal northern California, and Cretaceous radiolarian cherts and MOR basalt-like lavas from the outer Mariana forearc (Bevis, M. *et al.*1995, Sliter, W.V. *et al.* 1986., and Johnson, L.E. *et al.* 1991.) also are counter to a non-subduction belief. Earth expansion has been criticized for not incorporating subduction into its framework-and rightfully so-but in fact plate tectonic or earth expansion could account for subduction. Large amounts of ocean water are released not only by volcanism and MOR's but also by lithosphere hydration above subducting slabs (Peacock, S.M 1993.).

Pre-Mesozoic plate tectonic models abound for numerous ocean basins that presumably closed up later by subduction. These models are often proposed without first testing them palaeomagnetically. When Proterozoic APW path segments are superimposed for a model joining North America with Australia, the paths, though subject to refinement, showonly a crude match, and polarity misidentification for one of the data sets must be assumed (Idnurm, M. and Giddings, J.W. 1995).

Sen reasons that the solid mantle would prevent mantle convection. The lower mantle is indeed stiff and has a high viscosity, but the upper mantle is much less viscous and probably undergoes a slow, subsolidus thermal convection by radiogenic and outer core heating (Oslon, P. *et al.* 1990, Lay, T. *et al.*1990 and Kerr, R.A 1996.). Three-dimentional spherical models suggest that upwelling plumes and downgoing slabs are the dynamic features of mantle convection, while MOR's play a more passive role (Bercovici, D. *et al. 1989).*

The cause of earth expansion may not be entirely unknown. In an expanding earth, the total mass would remain essentially constant as the volume increases. Schloessin and Jacobs (Schloessin, H.H. and Jacobs, J.A 1980.) propose that the inner core and lower mantle have been growing at the expense of the initially much more extensive liquid core, leading to mass redistribution and heat loss. Laboratory experiments indicate that liquid iron chemically reacts with silicate perovskite at core-mantle boundary pressure and temperature conditions, causing the perovskite to thermally expand (Knittle, E. *et al.*1986 and Knittle, E. and Jeanloz, R. 1991). This reaction, extended over several billion years, may account for much of the increase in Earth's volume since silicate perovskite is the main constituent of the lower mantle. The gravitational pull of planetary bodies as the cause of expansion, however, appears unlikely. This gravitational influence is clearly dominated by the Moon.

Tidal rhythmites imply an Earth-Moon distance of 96% of the present distance at 650 Ma, and the Proterozoic data would rule out a close approach during the past 3,000 Ma (Williams, G.E., 1989).

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Comment on the paper "**Occurrence of Ultramafics of Komatiitic affinity in the Rikhabdev-Dungarpur Belt, Udaipur and Dungarpur districts, Rajasthan**" by R.C. Gathania, A.K. Chattopadhyay, B. Sharma, S.S. Ameta and A.K. Ghosal, Jour. Geol. Soc. India, v.46, No.6, 1995, pp.585-594.

It is interesting to note that komatiitic affinity of the ultramafics in the Rikhabdev-Dungarpur belt, Rajasthan is suggested based on the recent studies carried out by the authors. This observation may further strengthen the view that this belt may after all possess a favourable geological environment for locating nickel sulphide deposits - either massive, lenticular bodies or low-grade/high-grade disseminated deposits.

I would draw the attention of the authors to the results of geochemical reconnaissance surveys carried out by Raghu Nandan and Chattopadhyay (1976) during 1971-72 in

Rakhabdev (as spelt earlier) - Dhelana - Dewal areas in Udaipur and Dungarpur districts as this report has not been referred to. Besides recording fairly high values of Cr and Ni in the ultramafites, the regional geochemical surveys indicated some promising sectors from the point of view of mineralisation, *viz*, (1) about 1.5 km south east of Rakhabdev, Ni values ranging from 700 to 2500 ppm in dolomite band (highly altered and ferruginous) in contact with serpentinite, but with low Cu, Pb, and Zn; (ii) about 5.5 km north-north west of Rakhabdev, 0.10 to 0.26% Ni, 100 ppm to 0.35% Cu and Pb, Zn values ranging from 200-600 ppm in dolomite occurring close to the serpentinite body, and (iii) about 3.5 km north-east of Dewal, quartzite associated with talc-carbonate rock (characterised by a few old workings) hosts multimetal mineralisation - Cu (up to 0.42%) - Zn (up to 0.48%) - Ni (200- 500 ppm, one sample assayed 0.48%). Large heaps of slag in the vicinity suggests ancient mining and smelting activity - 2 samples assayed 0.19-0.29% Zn, over 1000 ppm Cu and 200 ppm Ni.

In Western Australia, Nickel-Sulphide deposits (Harrison, 1990) are associated with volcanic peridotite (Komatiite) as in Kambalda, Windarra and intrusive dunite (e.g. Agnew). Therefore, this ultramafic belt, nearly 100 km long deserves intense exploration for Ni, keeping in mind the possibility of locating sulphide mineralisation which may be the result of assimilation of sulphide bearing sediments (Ca-Fe-Mg rich) by the periodotite (komatiitic) magma. It is important that the intrusive dunite bodies and komatiitic volcanics are mapped in great detail to understand the relationship between the two types and nature of emplacement.

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Reply

The authors thank Shri K.R. Raghu Nandan for commenting on the economic potential of the komatiitic ultramafics of the Rikhabdev-Dungarpur Belt. However, it may be pointed out that the objective of our paper was to report the komatiitic nature of the ultramafics of the area based on limited field and analytical data. The mineralisation aspect of the ultramafics or the relevant literature thereof was, therefore, not discussed in the said paper.

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