A note on the occurrence of columbite–tantalite bearing pegmatite at Limboi, District Sabarkantha, Gujarat

Although some rare earth and rare metal minerals like gadolinite ($Be_2 FeY_2 Si_2O_{10}$) associated with distinct large crystals of tin, from some tourmaline pegmatite of Palanpur–Hosainpur area[1] and pyrochlore ($Na_2CaNb_2O_6$) from carbonatite of Ambadongar area[2] are recorded in Gujarat, the presently reported columbite–tantalite (Fe, Mn) O (Nb, Ta)$_2$O$_5$ mineralization, which occurs as a discrete mineral phase in the granitic pegmatite in the Limboi area, district Sabarkantha, is first of its kind located in Gujarat.

Columbite–tantalite mineralization in the deluvial/eluvial pegmatite gravel around the quartz core, with a grade of 0.03–0.06% of the mineral by weight, has been established by preliminary test-pitting and panning at Limboi. Columbite–tantalite pieces vary from 5 to 50 mm across and a sample analysed by X-ray fluoroscence (XRF) has 60.07% Nb_2O_5, 15.35% Ta_2O_5, 1.29% Y_2O_3, 1559 ppm Sn, 0.30% Ce_2O_3 and less than 20 ppm Ba. Columbite–tantalite (confirmed by X-ray diffraction studies) is radioactive and has assayed 1.2% eU_3O_8, 0.2% U_3O_8 and 2.4% ThO_2, by conventional radiometric methods. Chemical analysis of another columbite–tantalite sample from the Limboi occurrence has shown 53.6% Nb_2O_5, 12.1% Ta_2O_5, 1.5% TiO_2, 2.71% Y_2O_3, 1.3% WO_3, less than 0.1% SnO_2 besides 0.288% U_3O_8 and 1100 ppm ThO_2. Other ore minerals that are present at Limboi include fersmite (Ca, Ce, Na) (Nb, Ta, Ti)$_2$ (O, OH, F)$_6$, fluorite and beryl.

The Limboi columbite–tantalite pegmatite, emplaced within the Idar granite pluton is an interior type of zoned granitic pegmatite which trends NNE–SSW and measures 350 × 200 m (Figure 1) and forms two distinct mounds. It comprises a prominent and highly fractured quartz core surrounded by an intergrowth zone consisting of quartz, K-feldspar, muscovite and tourmaline with columbite–tantalite, fersmite, fluorite and beryl. This zone is largely covered by soil and eluvial gravels. High yttrium content up to 2.71% Y_2O_3 in the columbite–tantalite samples from this pegmatite may suggest possible presence of xenotime, in the vicinity.

In view of a close cluster of pegmatites and massive quartz veins in the Idar–Verabar ghat section, the area in the neighbourhood of Limboi pegmatitic occurrence was further examined, to explore the possibilities of locating some more columbite–tantalite occurrences. This resulted in the location of three more pegmatite occurrences, viz. Sarangpur, Sabalwada and Bhavangadh (Figure 2) Columbite–tantalite samples from Sarangpur (23°51′47″N : 72°57′41″E, Toposheet No. 46A/13) have shown 51.80 to 52 89% Nb_2O_5, 21 07 to 21.37% Ta_2O_5 and 1.87 to 2.01% SnO_2.

The proterozoic rocks of the north Gujarat comprise mainly the metasedimentary sequences of the Aravalli and Delhi Supergroups with associated synkinematic as well as post kinematic, (Post Delhi), late Proterozoic granites. Post tectonic suites of intrusive granitic rock with dominant pegmatitic phases characteristically mark the close of igneous activity. The intrusion of granitoids during the period 950–700 Ma also resulted in widespread migmatization of the preexisting rocks in North Gujarat and SW Rajasthan, in the southern part of Aravalli–Delhi fold belt. Such younger phases of granitoids are known to yield residual fluids, which could be anomalously rich in rare metals and rare earths, depending upon the degree of fractionation The trace element geochemistry and geochronology of the Idar granite[3] clearly correspond with the Erinpura granitic suite of rocks, dated 740 ± 10 Ma (ref. 4), occupying large tracts in the adjoining Banaskantha district (Gujarat) and Sirohi district (Rajasthan). These are highly differentiated granites and constitute younger fertile phases which might have contributed rare metals and rare earths to the mid-Proterozoic metasediments of Delhi Supergroup, in the contact zones and peripheral parts of the granite batholith

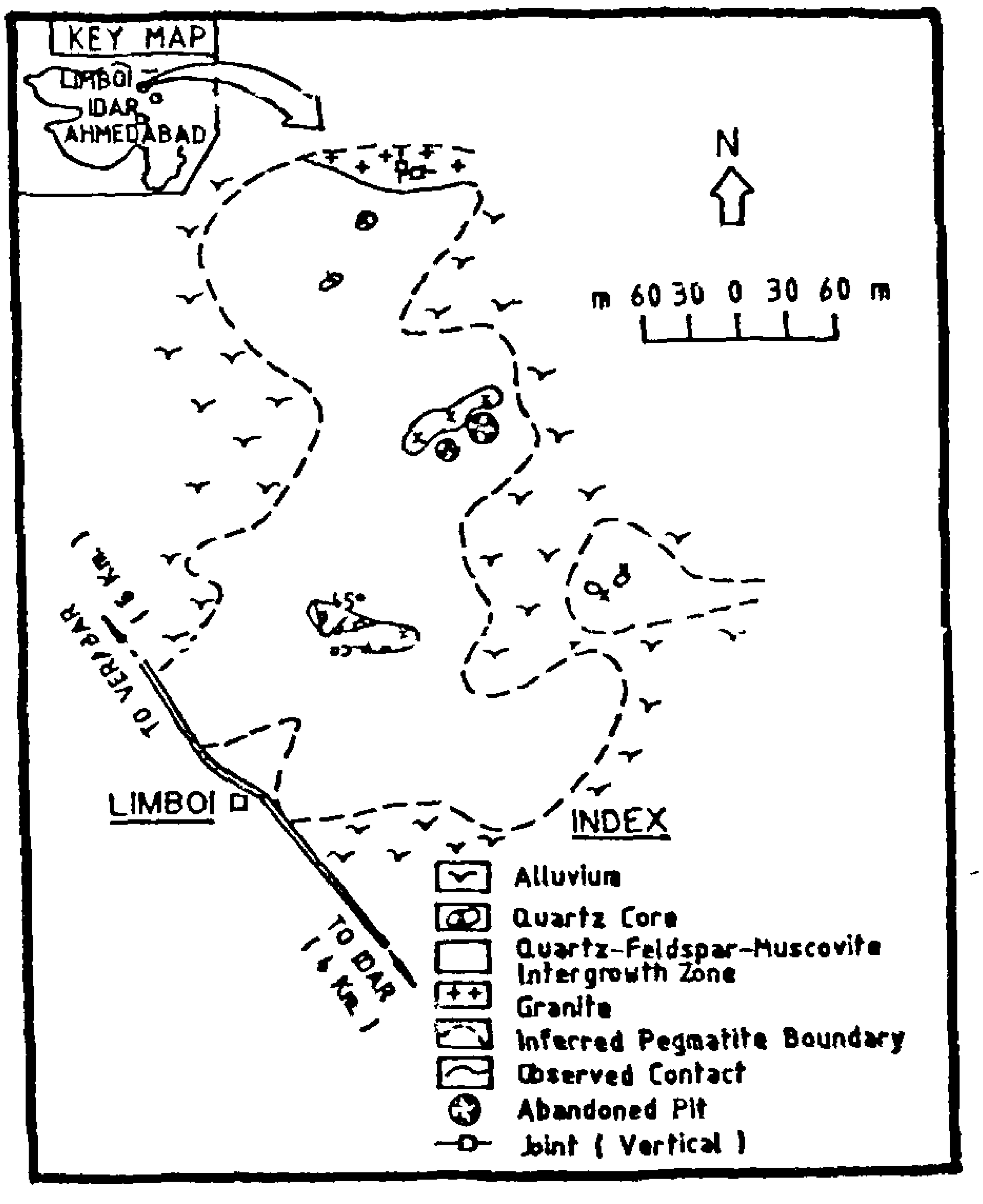

Figure 1. Geological map of Limboi pegmatite, Sabarkantha district, Gujarat.

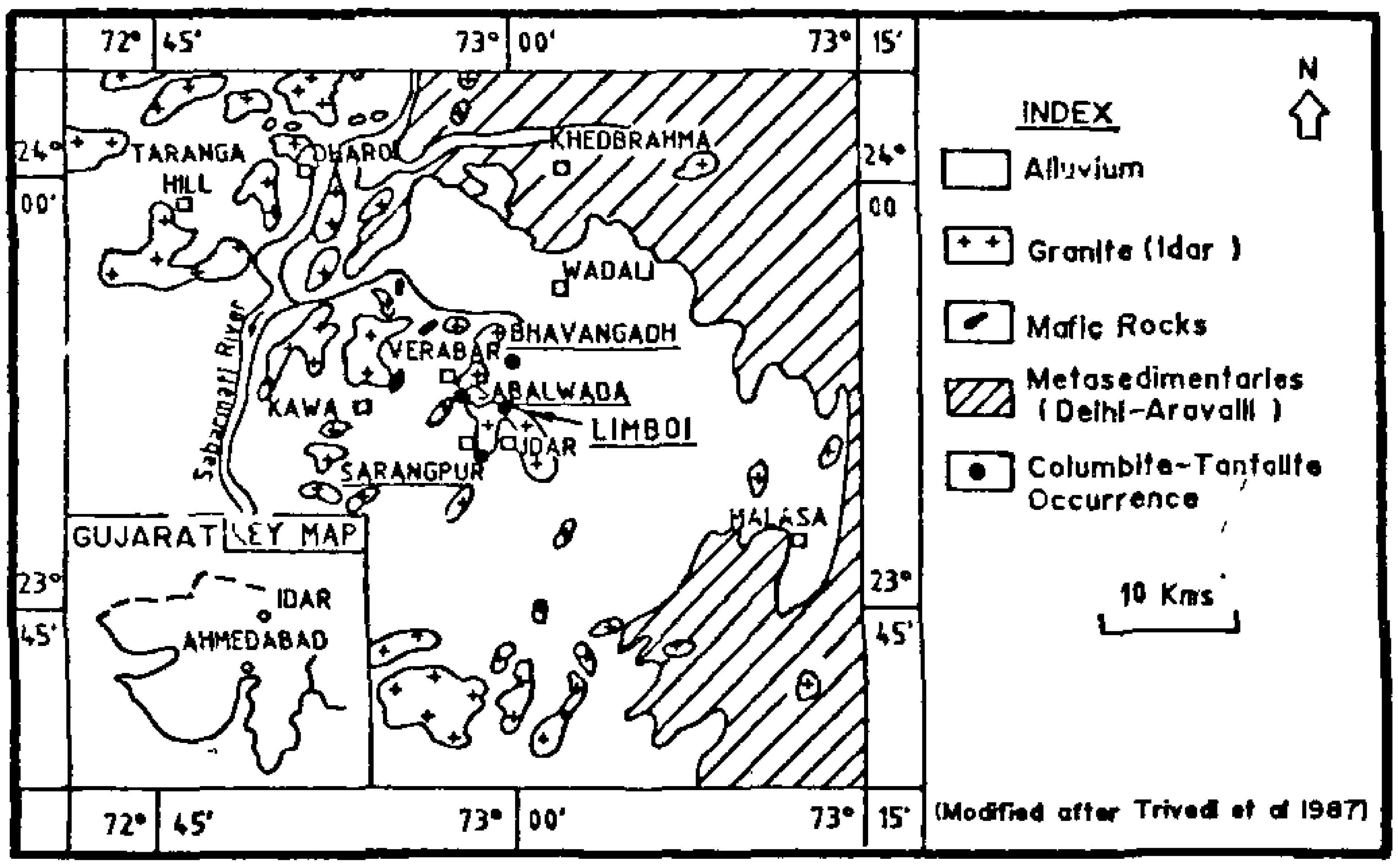

Figure 2. Geological map of Idar Area, North Gujarat, showing columbite–tantalite occurrences

The presence of columbite–tantalite-bearing pegmatites around Limboi and granitic terrain occupying about 1200 km^2 have opened up vast area for exploration of rare metals and rare earths. Follow-up investigations in the area around Verabar, Kawa, Dharoi, Nadri, Nawawas, in the Sabarkantha district of Gujarat and also in the adjoining Banaskantha district of Gujarat and Sirohi district of southwestern Rajasthan are likely to be rewarding, as fertile granites are present in the area.

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RESEARCH NEWS

Discovery of the new radiation belt of the earth

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The discovery of the new – the third-radiation belt of the earth has followed from the results obtained with the help of earth-orbiting satellites[1]. This discovery was made in three stages. The first evidence came in a striking manner in the Indian cosmic-ray experiment[2,3] in the SKYLAB-III mission of NASA during 1973–74 Further evidence was obtained from the results of the COSMOS satellites[4] of USSR flown in 1985–88. Finally, the confirmation and identification of the new belt was made from the results of the SAMPEX satellite[5] of NASA of USA in 1993.

Firstly, let us have a brief look at the two well-known radiation belts of the earth, the inner and outer belts discovered in 1958–59. These are also called Van Allen Belts after their discoverer, J. A. Van Allen of USA A number of satellite experiments were needed to understand their properties and origin. The inner belt consists of energetic charged particles, mostly protons (of energy ~ 10 to 100 MeV) and some electrons which are confined in a dough-nut shaped volume around the earth by the earth's magnetic field. The charged particles travel in spiralling paths around the magnetic field lines and they oscillate between the north and south hemispheres. At the same time they circle around the earth, forming a belt-like structure. The centre of the inner belt is located at about 3,600 km altitude where intensity of fast protons is enormously high. Similarly, the outer belt, which is composed of mostly fast-moving electrons, extends from ~ 10,000 to 70,000 km altitude. It has extremely high intensity of fast electrons near its core at 20,000–30,000 km These trapped radiation belts present serious radiation hazards to man and instruments in these regions of space.

A new kind of cosmic rays were first seen in interplanetary space in experiments on Pioneer 10 and 11 and IMP-8 spacecrafts of USA in 1973–74 (refs. 6–8). These new components of cosmic rays, called anomalous cosmic rays, were first seen in near-earth space, inside the earth's magnetic field in the Indian cosmic-ray experiment[2,3] on the Skylab-III mission of NASA. The surprising result found in this experiment was that the measured intensity in the solid state track detectors in Skylab was at least 25 times higher than the calculated value from the data in interplanetary space. How could it be possible?

It was proposed by the Indian group[3] that some of the anomalous cosmic-ray