Indian Journal of Marine Sciences
Vol. 18, September 1989, pp. 195-197

Provenance studies of Chirala coastal glass sand deposit, east coast of India

P Sankara Pitchaiah
Department of Geology, Nagarjuna University, Nagarjunanagar-522 510, India
and
A T Rao
Department of Geology, Andhra University, Waltair-530 003, India
Received 23 March 1989; revised 26 June 1989

Mineralogy and chemical and optical properties of Chirala coastal glass sand deposit have been studied. Common hornblends and epidotes are predominant among nonopaque minerals. Euhedral zircons are common. Hornblende and epidote abundance and their chemical and optical properties suggest that Nellore schist belt as the chief source for these sands. Shape and length-breadth ratios of zircons further support the schist belt provenance. Low presence of garnets, sillimanites, rounded zircons and zircon high-elongation frequencies indicate minor contribution from khondalites and charnockites. Major confinement of Gundlakamma river to Dharwarian schistose rocks and Archaean granitic gneisses suggest that the Nellore schist belt might have been actively eroded and contributed the sediment to a large extent to this coastal sand belt.

Glass sand deposit of Chirala coast (long. 80°15′ to 80°33′45″ and lat. 15°42′ to 15°57′30″) is a part of the coastal plain and 3-6 km away from the present shoreline. This sand belt has an aerial extent of about 145 km^2. The geological formations exposed around the sand belt are Archaean granitic gneisses, Dharwarian schists and gneisses, khondalites, charnockites, Cuddapah quartzites and shales.

The Cuddapah quartzites lying about 100 km west of the Chirala coast appears to be the possible provenance[1]. Beach sands are perhaps derived from the Archaean crystallines which occur about 20 km and beyond, west of the sand belt[2]. In the present investigation mineralogy, chemical composition and optical properties of Chirala coastal glass sand deposit have been studied and an attempt has been made to discuss the provenance of Chirala sands.

Materials and Methods

Glass sands are of coarse, medium and fine varieties[3]. Coastal sand samples (24) from three types (coarse, medium and fine grade sands) and 17 rock samples, exposed around sand belt were subjected to heavy mineral analysis[4,5]. Heavy minerals were identified and electron-probe microanalysis (ARL-Model) was done for dominant important heavy minerals. Detailed morphological characters of zircons were carried out. From each sample, length and breadth for 200 zircons were measured and plotted in frequency diagram.

Results and Discussion

Heavy minerals, identified in the glass sands are opaques, amphiboles, epidotes, zircons, garnets, tourmaline, rutile and rarely sillimanite. There is no significant variation in heavy mineral content (Table 1) except zircon, garnet and sillimanite, whose percentages are relatively low in fine sand grade. A brief description of identified heavy minerals is presented below.

Opaques – Magnetite and ilmenite are predominant. Opaques are present up to 74%. The grains are subrounded and subspherical.

Table 1 – Heavy mineral composition (%) of Chirala sands

Sand type	Opa	Hb	Epi	Zr	Ga	Tou	Ru	Sil
Coarse (av. 8)	73.18	15.04	8.32	1.55	0.70	0.45	0.31	0.45
Medium (av. 8)	73.25	14.80	8.40	1.43	0.71	0.60	0.39	0.41
Fine (av. 8)	73.88	15.54	8.16	0.90	0.39	0.41	0.39	0.25

Opa = Opaques; Hb = Hornblende; Epi = Epidote; Zr = Zircon; Ga = Garnet; Tou = Tourmaline; Ru = Rutile; and Sil = Sillimanite

Hornblende—It is abundant among non-opaque minerals (15.54%). Crystals are prismatic in shape. Chemical analysis and optical properties of hornblende are given in Tables 2 and 3 respectively. Si and Al are abundant. Ca, Fe and Mg enrichment is obvious in the hornblendes. Mn, Ti and F are present as minor constituents. K is not recorded. Optic axial angle varies from 72°-80° and the α:z is 14° to 22°. Strong pleochroism is observed and it is in variable greens, i.e. yellowish green, bluish green and light yellow. The data are comparable with these of schistose belt hornblends[6].

Table 2 — Chemical analysis of hornblendes and epidotes (percent values average of coarse, medium and fine sands)

	Hornblendes	Epidotes
SiO_2	43.038	36.993
TiO_2	0.964	0.077
Al_2O_3	15.449	23.749
*FeO	16.012	12.733
MnO	0.357	0.128
MgO	9.522	0.659
CaO	10.797	23.950
Na_2O	2.229	—
K_2O	—	—
F	0.129	—
**H_2O	1.504	1.711
	100.001	100.00
	No. of ions on the basis of 24 (O,H,F)	No. of ions on the basis of 13 (O,OH)
Si	6.3808	3.0210
Al^{IV}	1.6192	—
Al^{VI}	1.0803	2.2859
Ti	0.0178	0.0390
Fe^{2+}	1.9850	0.8696
Mn	0.0445	0.0088
Mg	2.1043	0.0799
Ca	1.7150	2.0959
Na	0.6396	—
K	—	—
OH	0.7439	0.4657
F	0.0605	—

*Expressed as total iron
**Assumed content

Epidote—Epidotes are next in abundance to hornblendes in the coastal glass sands (8.4%). The grains are subrounded to subspherical in shape. Chemical and optical axial angle varies from 82°-84° and α:z is 10°-20°. It is pleochroic in shades of green and yellow and biaxial negative. Al enrichment is distinct. Ti, Mn and Mg are in low quantities. Alkalies and F are not recorded. The data are comparable to those of granitic rocks of Nellore schist belt[6].

Zircons—Zircons in coastal sands and rocks exposed in the investigated area are of different types-euhedral (90-95%) rounded and terminated, rounded and without overgrowths (Table 4). The grains are colourless to greenish yellow and rarely pink. The data of length-breadth ratios are presented in Table 5 and shown in Fig. 1. About 88% of the Zircons are confined to 1.5 to 2.5 range. Comparative data of zircon types, length-

Table 4 — Comparative account of zircon types (%)

Rock/sediment type (No. of samples)	Zircon types			
	Euhedral	Rounded terminated	Rounded	Without overgrowths
Chirala sands (24)	94	2-4	1-3	—
Khondalites (3)	—	—	100	—
Acid charnockites (2)	71	29	—	—
Pyroxene granulites (2)	44	31	23	2
Leptynites (2)	4	29	2	65
Granites (3)	95	2-4	2-4	—

Table 3 — Optical properties of hornblendes and epidotes

	Hornblendes			Epidotes		
	Coarse	Medium	Fine	Coarse	Medium	Fine
2Vα	75°-80°	74°-78°	72°-80°	82°	80°	84°
α : z	20°-22°	14°-17°	15°-20°	←	10°-12°	→
α	1.668	1.673	1.664	1.721	1.722	1.723
β	1.688	1.690	1.686	1.737	1.744	1.746
γ	1.695	1.698	1.691	1.753	1.761	1.766
γ-α	0.027	0.025	0.027	0.032	0.039	0.430
Pleochroism						
α	Light yellow	Pale yellow	Light yellow	Colourless	Pale yellow	Pale yellow
β	Yellowish green	Pale yellowish green	Yellowish green	Pale greenish yellow	Pale greenish yellow	Pale yellow
γ	Bluish green	Pale bluish green	Bluish green	Pale yellowish green	Pale yellowish green	Pale yellowish green

Table 5 – Length-breadth ratios of zircons

Rock/sediment type (No. of samples)	Length-breadth ratios							
	1.0	1.25	1.5	2.0	2.5	3.0	3.5	4.0
Chirala sands (24)	–	–	19	45	24	8	3	1
Khondalites (3)	–	69	21	10	–	–	–	–
Acid charnockites (2)	–	–	19	66	9	4	2	–
Pyroxene granulites (2)	23	–	54	16	5	1	1	–
Amphibolites (2)	25	–	48	16	8	3	–	–
Mica schist (2)	–	77	15	8	–	–	–	–
Granites (3)	–	–	20	45	22	8	4	1

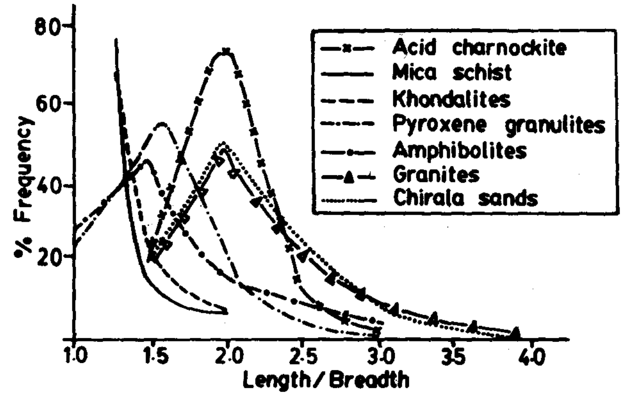

Fig. 1 – Comparative diagram of elongation frequencies for zircon

breadth ratios and their elongation frequency curves (Fig. 1) obviously support that the coastal glass sand data are comparable to granite zircons.

Other minerals – Garnet, tourmaline, rutile and sillimanite are observed in low percentages (Table 1).

Provenance – Abundance of hornblendes and epidotes and their chemical and optical properties suggest Nellore schist belt[6] as the provenance for the glass sands. Tourmaline which is not recorded in granulite grade rocks, and the scarce occurrence of sillimanite indicate the low contribution of material from the granulite grade rocks.

Euhedral zircons are common in granites from Nellore schist belt[6] and acid-charnockites from the granulite grade rocks. The euhedral zircons from acid charnockites have higher elongation frequencies compared to granites from Nellore schist belt. Rounded zircons are more prominent in the khondalites. The low percentage of rounded zircons (characteristic of khondalites) and zoned pink euhedral zircons (characteristic of acid charnockites) in the glass sands, support limited contribution from the granulite grade rocks. An overall comparison of elongation frequencies of zircons (Fig. 1) further supports the Nellore schist belt as the chief source.

The Gundlakamma, a medium sized river joins the Bay of Bengal about 14 km SW of the sand belt and appears most likely to have transported the sediment[3]. The drainage pattern of Gundlakamma river is mainly confined to the Dharwarian schistose rocks and Archaean granitic gneisses[7]. This indicates that the Nellore schist belt is worn down by an active erosion and has contributed to a great extent to the glass sand belt.

Acknowledgement

The authors are deeply grateful to Mr. Russel, B. Merrill and Mr. W.L. Haung of the Department of Geophysical Sciences, University of Chicago, USA, for carrying out the electron-probe microanalysis. Financial assistance from the U.G.C. to the first author is gratefully acknowledged.

References

1 Jacob K, *Rec Geol Surv India*, 82 (1956) 603.
2 Rao M G, *Indian Minerals*, 27 (1973) 60.
3 Rao A T & Sankara Pitchaiah P, *Indian J Mar Sci*, 14 (1985) 136.
4 Krumbein W C & Pettijohn F J, *Manual of sedimentary petrography*, (Applton-Century-Crofts, New York) 1938, pp. 549.
5 Milner H B, *Sedimentary petrography*, (Allen and Unwin, London) 1962, pp. 643.
6 Rao A T, *Mineralogy and petrology of the precambrian rocks around Kandra, Nellore mica belt, Andhra Pradesh, India*, Ph.D. thesis, Andhra University, 1972.
7 Sankara Pitchaiah P, *Sedimentology and economic geology of the glass sand belt from Prakasam district, Andhra Pradesh*, Ph.D. thesis, Andhra University, 1985.