SHORT COMMUNICATION

SEDIMENTOLOGICAL ATTRIBUTES OF SANDSTONES FROM TALCHIR FORMATION, CHIMUR AREA, CHANDRAPUR DISTRICT, MAHARASHTRA

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Sandstones from the Talchir Formation around Chimur area are well exposed in a trough sub-parallel to main Pxanhita-Wardha Valley *(PYI\) %nd Wardha* Valley Gondwana Basin (WVGB). These sandstones are poorly sorted, show wide lateral continuity with horizontal laminations as well as scour and *f\\[* structure. Glacial depositional environment and interior craton type of continental block provenance are suggested for Talchir sandstones.

Introduction

The Talchir Formation is exposed in an isolated trough around Chimur, Chandrapur Distract, Maharashtra (Fig.l), sub-parallel to that of Pranhita-Wardha Va)]ey (PWV) (Raja Rao, 1982). A wide stretch of Archaean metamorphics and Sullavai quartzites separates these outcrops from the main Wardha Valley Gondwana Basin (WVGB). The Talchir Formation comprises bould$_{er}$ bed and sandstones. Petrography, textural parameters, x-ray diffraction (XRD), scanning electron microscope (SEM) and heavy mineral data on sandstones are presented in this communication.

Geological Setting

The Gondwana sediments unconformably overlie the Archaean metamorphics and quartzites of the Sullavai Group around Chimur. The Talchir, Barakar and Kamthi Formations constitute the Gondwana sediments, which are in turn, overlain by the Lameta Formation and the Deccan Trap (Table 1).

The Talchir Formation consists of boulder bed and sandstones. The boulder bed occurs as lensoid units and laterally discontinuous beds varying in thickness from 0.5 to 2.0 m. These are yellowish brown, poorly sorted and made of feldspathic gneisses and quartzite boulder$_s$ randomly dispersed in a fine sand and silt matrix. The boulder bed grades upwards into yellowish brown, fine to medium grained[1] sanasfones snowing wia'e fateraf continuity with thickness varying from 0.2 to 2.5 m. Sandstones exhibit horizontal laminations with scour and fill structures. At places, thin layers of varved clays alternate with sandstones.

Table 1. Stratigraphic succession of the Chimur area (essentially after Raja Rao, 1982)

Age	Group/Formation	Litholojjy
Recent	-	Alluvial gravel, soil
	Unconformity	
Eocene	Deccan Trap	Tholentic basalt
	Unconformity	
Cretaceous	Lameta	Limestone, chert and silicified sandstone
	Unconformity	
Late Permian to Early Triassic	Kamthi	Yellow and buff sandstone Yellow clay
	Unconformity	
< g; a O Late Carboniferous	Barakar	Fine to coarse giained sandstone, grey shales and coal seams
	Talchir	Very fine grained sandstone and siltslone with pebbles and bouldeis
Early Permian		Fine grained sandstones and clays
	Unconformity	
Proterozoic	Sullavai	Quartzites
	Unconformity	
Archaean	-	Metamorphics

Sedimentological Attributes

Eighteen sandstones samples were subjected to petrographic studies. The roundness grades of Pettijohn (1984) and sphericity ranges after Folk (1965) were used. Following Ingram (1971), the sieve analysis was accomplished. The data thus obtained were processed for evaluating textural parameters as proposed by Folk and Ward (1957). X-ray diffraction (XRD) studies and scanning electron microscope *(SEM)* studies of six samp/es were carried out as illustrated by Gibbs (1971) as well as Hardy

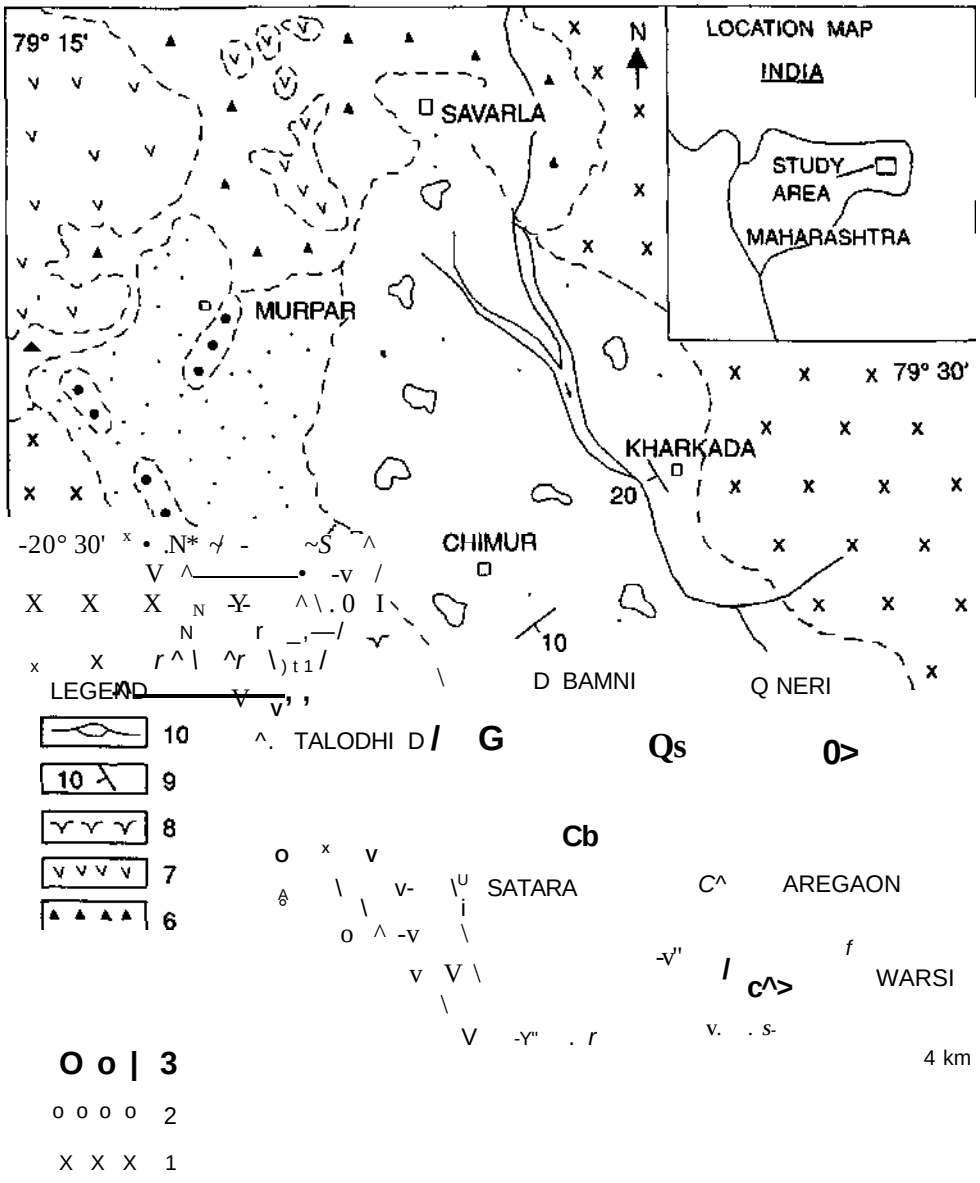

Fig.1. Geological map of Chimur *{after* GSI, 1979). 1- Archaeans, 2 - Sullavai Group, 3 - Talchir Formation, 4 - Barakar Formation, 5 - Kamthi Formation, 6 - Lameta Formation, 7 - Deccan Trap, 8 - Alluvium, 9 - Dip and strike of bed and 10 - River.

and Tucker (1988) and Krinsley and Doornkamp (1973) respectively. The heavy mineral separation is carried out as per procedure laid down in Carver (1971).

The framework constituents in sandstones include quartz (37.83%), feldspar (21.39%), rocks fragments (4.18%) and the accessories (0.56%). The matrix content ranges up to 36%. These sandstones are mainly cemented by ferruginous material. Based on the classification proposed by Pettijohn (1984), these sandstones are categorized as feldspathic grey wacke.

Monocrystalline quartz (26.80%) dominates over the polycrystalline quartz (11.03%). Among monocrystalline quartz grains, non-undulating quartz (25.99%) predominates over the undulating quartz (0.81%). The quartz grains on the whole are sub-angular (0.16-0.28) to sub-rounded (0.32-0.58) with the sphericity range of sub-elongate (0 66-0.69) to elongate (0.63-0 66). Feldspars are mainly microcline and orthoclase with minor plagioclase. Feldspars are fresh and sub-rounded. The metamorphic rock fragments include quartzite and schist. The three components, namely

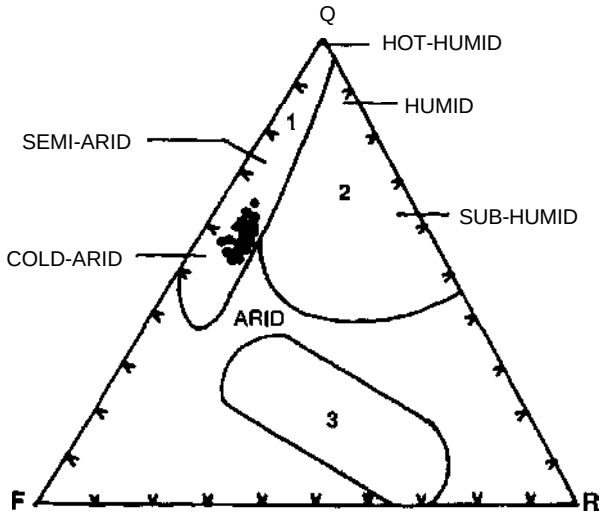

Fig.2. QFR triangular diagram of Talchir sandstones of Chtmur *(after* Suttner and Dutta, 1986, Provenance field boundaries are taken from Dickinson and Suczck, 1979) Q - Quartz, F - Feldspar, R - Rock fragments 1 - Continental block provenance, 2- Recycled orogen provenance and 3 - Magmatic arc provenance

quartz (Q), feldspar (F) and rock fragments (R) are plotted in QFR diagram (Fig.2) to deduce palaeoclimate and provenance.

The graphic mean for sandstones varies from very fine sand (Mz = 3.66<p) to medium sand (Mz = 1 860) with polymodal grain size distribution (Table 3). The inclusive graphic standard deviation values suggest that sandstones are predominantly poorly sorted (a, =1.16^). The inclusive graphic skewness values point out that the samples are positively skewed (SKj = +0.21) to very positively skewed (SK, = 0.47). These samples of positive skewness indicate the dominance of coarse sized population over the finer and represent mixing of two or more sub-equal grain size population. For these sandstones, the graphic kurtosis values are found to range between very leptokurtic (K_G = 1.77) to leptokurtic (K_G = 1.29).

X-ray diffraction (XRD) data indicate that illite and chlorite are predominant minerals in clays separated from matrix in sandstones. The scanning electron microscope (SEM) study of quartz from sandstones samples has brought out striations (Fig.3a), chatter marks and conchoidal fractures (Fig.3b). At places, small ridges on quartz grains are also traced out (Fig.3c). Besides, the small-scale breakage blocks, arc shaped steps and 'V shaped indentations are also noted (Fig.3d).

Zircon (9.95%), tourmaline (3.21%), rutile (0.51%), garnet (88.04%), epidote (0 79%), silhmanite (0.18%) and staurolite (0.18%) are the heavy mineral constituents (Table 4).

Three varieties of sub-rounded to rounded zircons namely, colourless (major proportion), pink and yellow (minor proportion) are noted. Pyramidal faces and opaque

Table 2. Results of the modal analysis of sandstones from Talchir Formation around Chimur area

Sample No	Monocrystalhne Nudl	Undl	Quartz Total	Pier Quartz	Total Quartz	Feld	Rkfgr	Others	Matrix
Tl	30 46	.	30 46	9 32	39 78	20 12	5 34	-	34 76
T2	18 12	-	18 12	8 04	26 16	2109	-	-	52 75
T4	18 76	0 72	19 42	10 02	29 44	20 04	-	-	50 52
T7	30 79	231	33 10	10 88	43 98	2192	5 73	0 92	27 45
T8	36 71	-	36 71	8 34	45 05	20 89	481	0 86	28 39
T9	20 52	-	20 52	12 76	33 28	24 34	7 21	102	34 15
T10	29 54	-	29 54	10 86	40 40	21 37	451	0 12	33 60
T12	30 76	-	30 76	12 36	43 12	21 71	4 44	0 98	29 75
T13	34 51	-	34 51	9 36	43 87	22 64	4 46	0 37	28 68
T14	18 42	4 15	22 57	13 91	36 48	22 12	5 10	0 12	36 18
T16	26 50	-	26 50	12 75	39 25	22 08	601	1 11	31 35
T21	15 82	3 27	19 09	9 34	28 43	20 77	3 23	0 96	47 21
T22	22 38	2 93	25 31	9 82	35 13	22 52	521	I *10*	36 04
T23	31 81	-	31 81	11 53	43 34	19 35	3 01	0 78	33.52
T24	17 66	-	17 66	14 64	32 30 .	21 19	4 73	091	40 87
T27	22 47	1 12	23 59	15 06	38 65	20 96	3 95	0 14	34 57
T29	27 55	-	27 55	12 20	39 75	21 59	3 95	0 14	34 57
T30	35 17	-	35 17	11 34	46 51	20 98	3 67	0 35	28 49
Average	**25.99**	**0.81**	**26.80**	**11.03**	**37.83**	**21.39**	**4.18**	**0.56**	**36.00**

(Nudl - Non-undulating, Undl - undulating, Pier - Polycrystalhne, Feld - Feldspar, Rkfgr - Rock fragments)

Table 3. Textural parameters of sandstones from Talchir Formation around Chimur area

Sample No.	Mz(ϕ)	σ_1(ϕ)	Vc	SK_1	Vc	K_G	Vc
T1	2.60	1.13	P_s	+0.25	PS	1.79	VLK
T2	3.46	1.35	P_s	+0.02	NS	1.36	LK
T4	3.92	1.06	P_s	+0.11	PS	1.98	VLK
T7	3.61	1.03	P_s	+0.50	VPS	1.58	VLK
T8	1.82	1.15	P_s	+0.20	PS	1.65	VLK
T9	2.55	1.14	P_s	+0.23	PS	1.81	VLK
T10	2.43	0.71	M_s	+0.07	NS	1.15	LK
T12	2.72	1.23	P_s	+0.54	VPS	1.19	LK
T13	2.76	1.21	P_s	+0.51	VPS	1.37	LK
T14	1.88	1.27	P_s	+0.37	VPS	1.39	LK
T16	2.56	1.15	P_s	+0.28	PS	1.80	VLK
T21	2.62	1.14	P_s	+0.26	PS	1.81	VLK
T22	3.87	1.11	P_s	+0.13	PS	1.95	VLK
T23	3.57	1.12	P_s	+0.24	PS	1.86	VLK
T24	2.20	0.90	M_s	+0.20	PS	1.19	LK
T27	1.91	1.18	P_s	+0.36	VPS	1.36	LK
T29	1.80	1.16	P_s	+0.23	PS	1.65	VLK
T30	3.58	1.06	P_s	+0.51	VPS	1.62	VLK

(Mz - Graphic Mean, σ_1 - Inclusive Graphic Standard Deviation, SK_1 - Inclusive Graphic Skewness, K_G - Graphic Kurtosis, Vc - Verbal Classification, P_s - Poorly sorted, M_s - Moderately Sorted, PS - Positive Skewed, NS - Near Symmetrical, VPS - Very Positive Skewed, VLK - Very Leptokurtic, LK - Leptokurtic)

inclusions are common in zircons. Yellowish brown variety of tourmaline is more common as compared to pale yellow variety. Rutile is dominantly brownish yellow. Garnets are colourless and occasionally pick variety, exhibit high relief, conchoidal breakage pattern, arc shaped steps, semi parallel steps and globular protuberances. Striations are also traced out from garnet surfaces.

DISCUSSION AND CONCLUSIONS

Sandstones from the Talchir Formation around Chimur bring out high percentage of matrix and framework constituents showing large variation in grain sizes indicating poor sorting. These petrographic characteristics suggest the textural immaturity of sandstones and fresh, sub-rounded feldspars divulge the deposition of these sandstones near

Table 4. Heavy mineral frequency percentage of sandstones from Talchir Formation around Chimur area

Sample No.	Zircon	Tourmaline	Rutile	Garnet	Epidote	Sillimanite	Staurolite	ZTR index
T1	8.24	2.19	0.28	88.98	0.21	0.10	-	10.71
T2	4.87	1.56	0.11	93.46	-	-	-	6.54
T4	0.80	0.29	-	98.20	0.08	0.63	-	1.09
T7	22.57	3.88	0.12	71.71	-	-	0.72	26.57
T8	9.15	3.75	0.16	85.82	0.68	0.44	-	13.06
T9	3.82	1.77	0.27	92.76	0.47	-	0.91	5.86
T10	8.43	2.58	-	88.97	-	0.02	-	11.01
T12	7.50	2.28	1.21	88.30	-	-	0.71	10.99
T13	11.56	4.36	1.23	81.97	0.88	-	-	17.15
T14	9.63	3.12	0.78	86.47	-	-	-	13.53
T16	4.89	4.26	0.23	90.37	-	0.02	0.23	9.38
T21	8.27	1.23	0.28	89.39	0.29	0.37	0.17	9.78
T22	2.99	0.16	0.14	96.58	-	0.03	-	3.29
T23	21.37	6.94	2.37	64.18	4.37	0.77	-	30.68
T24	20.12	6.54	1.98	66.67	4.22	0.47	-	28.64
T27	16.68	5.71	0.89	73.19	2.98	0.32	0.23	23.28
T29	9.47	3.68	-	86.85	-	-	-	13.15
T30	8.71	3.43	0.38	87.26	-	-	0.22	12.52

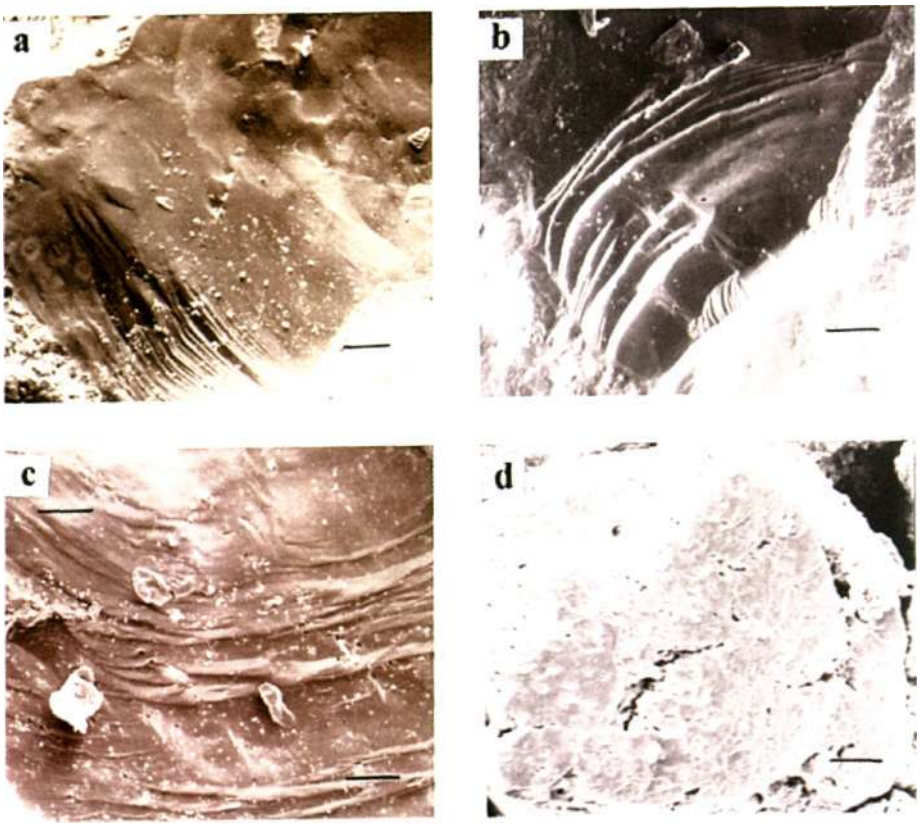

Fig.3. Scanning electron microscope images, (a) Quartz grain surface exhibiting striations (Bar scale measures 40u). (b) Conchoidal fractures on quartz grain (Bar scale measures 40p). (c) Ridges from quartz grain surface (Bar scale measures 40u). (d) Quartz grain surface showing ' V'-typc indentations (Bar scale measures 80u).

the source under cold-arid climatic condition (Pettijohn. 1984). The QFR diagram prepared for the sandstones of the Talchir Formation reveals cold-arid climate during their deposition (Suttner and Dutta, 1986) and interior craton type of continental block provenance (Dickinson and Suczek, 1979).

The wide range of grain size values from medium to very fine sands with polymodal distribution, poor sorting, positive to strongly positive skewness, and very leptokurtic to leptokurtic nature of sediments reflect the glacial environment for the deposition of the Talchir sandstones (Reineck and Singh, 1973; Soman and Kale, 1993; Hardas andMurkute. 2001).

Illite and chlorite are common in glacial sediments. The micro-textures like striations, chatter marks, conchoidal fractures, small-scale breakage blocks, arc shaped steps and 'V shaped indentations on quartz grain surfaces indicate glacial modes of deposition (Setlow and Karpovich, 1972; Whally and Krinsley, 1974; Trewin, 1988).

The colourless zircon and zircon with opaque inclusions indicate metamorphic source rocks for the sediments of Talchir sandstones (Borgohain et al. 1999). Sub-rounded to rounded zircons suggesting polycyclic nature, may ultimately be derived from Archaean metamorphic rocks (Poldervart, 1956). The derivation of these sediments from metamorphic source is further supported by the high percentage of garnet and the presence of sillimanite and staurolite. The low ZTR index (Hubert, 1962) of an average 13.67 % is indicative of mineralogical immaturity of these sediments, which in the present case, may be related to short distance of sediment transport and nearby source of metamorphic rocks. The striated garnets as well as presence of epidote point out the glaciogenetic origin of these sediments (Das et al. 1993).

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