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Provenance and depositional characteristics of Lathi Formation in southern part of Jaisalmer Basin: Implications for exploration of sandstone type uranium mineralization

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Abstract

The lower Jurassic Lathi Formation covers about 900 sq. km area and forms the lowermost unit of Jaisalmer Basin of western Rajasthan. Lithologically the Lathi Formation comprises of conglomerate, sandstone, siltstone, shale and mudstone. The sandstones are generally medium- to coarse-grained, moderately sorted and show variation in colour, grain-size and texture. Petrographic studies indicate a mixed provenance for the Lathi sandstone. On the basis of geochemical data, theses sandstones are classified into sub-arkose, litharenite and sub-litharenite. Palaeo-weathering indices such as CIA (80.45), CIW (85.23) and PIA (84.23) suggest moderate to high degree of chemical weathering of the source area, intermediate and felsic igneous provenance, under humid to semi-humid climatic conditions. Further, the geochemical data indicate the sedimentation in a passive continental margin setting. The Bouguer gravity image clearly depicts the north westward slope of the basement. Modelling studies of the gravity data revealed average depth to the basement as 800m, 400m and 250m respectively in northwest, central and southeastern parts of the surveyed area. Exploration activities by Atomic Minerals Directorate for Exploration and Research have resulted in location of several uranium anomalies in the Lathi Formation. Lathi Formation is characterised by many favourable parameters such as fertile provenance, arkosic sandstones intercalated with shale/mudstone, reduced sedimentary facies with carbonaceous matter, lignite and pyrite deposited in continental to marginal marine environment. Malani Igneous Suit and metamorphic rocks constitute the basement for Jaisalmer Basin. Malani rhyolites and granites are fertile source of uranium, containing 6.7 ppm and 9.2 ppm average and intrinsic uranium respectively. Presence of carbonaceous matter and pyrite bearing sandstones, indicative of reducing environment at depth below water table (R.L. 150 m), was reported during subsurface exploration in Lathi sandstone which is a favourable condition for Lathi sediments to host uranium mineralization.

Keywords: *Lathi sediments, Provenance, Sandstone type, Jaisalmer Basin*

Introduction

The Jaisalmer Basin is a pericratonic basin, and is located on the western Rajasthan shelf dipping due northwest (Fig.1). It contains about 10,000 m thick sediments of alternating succession of terrigenous sediments and carbonates. The lower Jurassic sedimentary succession of the basin is characterized by gradual lateral and rapid temporal facies changes with rich and highly diverse faunal contents (Pandey et al., 2012). The Lathi Formation of Jurassic age shows unconformable relationship with the underlying basement rocks while it has conformable relationship with the overlying Jaisalmer Formation.

The study area is located in and around Rama-Koda villages, 40 km south of Jaisalmer town and exposes sandstone, siltstone and conglomerate strata. This area is characterized by the presence of widespread oxidised sediments on the surface. The fresh and unaltered sediments and sections suitable for sedimentological studies and radiometric examination for uranium mineralisation are not exposed. Later, geological, geochemical and petro-mineralogical data obtained from the reconnoitory drilling carried out by AMD in southern part of the Jaisalmer Basin has further enhanced the understanding of the subsurface character of Lathi sediments. Though the oxidized sediments continue up to 150 m depth, the presence of reduced sandstone at depth below water table with carbonaceous matter and pyrite increases the favourable conditions of Lathi sediments to host uranium mineralization. Early stage of mechanical compaction and subsequent pervasive calcite and iron oxide cementation resulted in good amount of porosity with an average of 13.3% in the

Lathi Formation (Alam et al., 2000). The Lathi Formation drew attention of geologists and researchers over the past few decades due to its sedimentological attributes and fossil content. This formation has been studied by several workers especially for geology and basin configuration (Pareek, 1984), stratigraphy (Misra et al., 1993), diagenesis (Alam et al., 2000) and fossil content (Parihar et al., 2017). So far any substantial work has not been carried out on depositional characteristics of the Lathi Formation and its potential for uranium exploration. The present study focuses on sedimentological, petro-mineralogical and geochemical characterization to elucidate the facies pattern, provenance and depositional environment of the Lathi sediments in southern part of Jaisalmer Basin to assess favourability of the study area for hosting 'sandstone type' uranium mineralization.

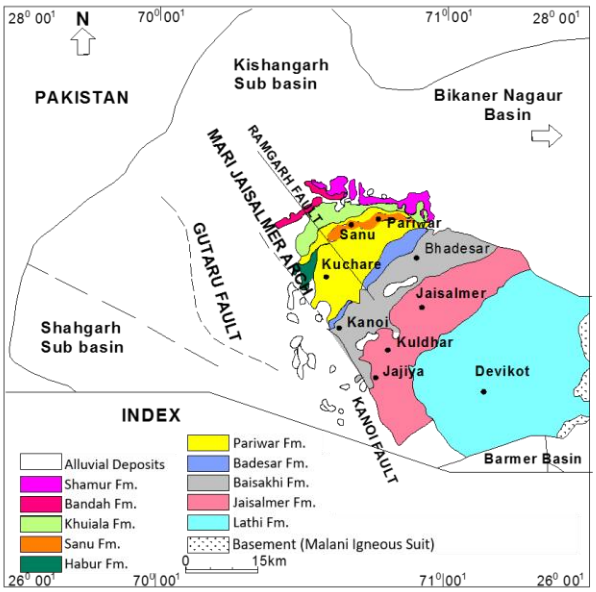

Fig. 1 Geological map of the Jaisalmer Basin (after Das Gupta, 1975)

Geological Setting

The Jaisalmer Basin with thick sedimentary succession has a long and well established sedimentation history from upper Palaeozoic to Quaternary with well-marked transgressive and regressive cycles (Singh, 2006, Table 1). The sedimentary strata have NE-SW strike and the basement configuration is characterized by westerly and north-westerly slope. The rhyolites and granites of Malani Igneous Suite and Proterozoic metamorphic rocks constitute the basement of the sedimentary successions in the Jaisalmer Basin. The sediments have been deposited in non-marine, shallow marine conditions, and range from terrestrial siliciclastic to marine carbonates. The Mesozoic succession of the Jaisalmer Basin start with fluvial, deltaic, or lacustrine sediments, followed by marginal marine sediments, which in turn are followed by several non-marine and

Table 1 Stratigraphy of the Jaisalmer Basin (Zadan et al., 2015)

Age	Formation	Rocktypes
Recent	Wind-blown sand/alluvium	Loose sand and alluvial material
Recent to Pleistocene	Shumar	Dune sand, gravel with ferruginous nodules
Middle Eocene	Bundah	Foraminiferal limestone, clays at base
Lower Eocene	Khuiala	Shales with limestone beds and calcareous silts
Paleocene	Sanu	Friable sandstone with minor clays
Upper Cretaceous	Parh	Marls and arenaceous limestone
Upper Cretaceous	Goru	Sandstone and Shale
Lower Cretaceous	Habur	Arenaceous limestone and calcareous sandstone
Neocomian	Pariwar	Sandstone and Shale
Upper Jurassic	Baisakhi/Bhadasar	Sandstone and Shale
Middle Jurassic	Jaisalmer	Sandstone and Limestone
Lower Jurassic	Lathi	Sandstone, Shale
Malani Igneous Suite (750-770 Ma)		

marine sediments (Das Gupta, 1975; Pareek, 1984; Mahendra and Banerji, 1989; Fursich et al., 1992; Pandey et al., 2005, 2006 a, 2012; Ahmad et al., 2017, 2020). The entire Mesozoic succession of the basin is divided into six formations viz. Lathi, Jaisalmer, Baisakhi, Bhadasar, Pariwar and Habur ranging in age from Lias to Albian. The Tertiary succession in the Jaisalmer Basin is divided into Sanu, Khuiala, Bandah and Shumar formations. Diverse micro and mega fossil assemblages comprising foraminifers, ostracods, corals and some plant fossils are dominantly present in these sediments and have attracted the attention of palaeontologists and sedimentologists (Ahmad et al., 2020). The Jurassic rocks of the Jaisalmer Basin begin with fluvial, deltaic or lacustrine sediments of the Lathi Formation, exposed in the south-eastern part of the basin (Srivastava, 1966; Lukose, 1972; Bonde, 2010). There have been several gradual changes in the depositional setting from fluvial/lagoonal, delta front, shoreface to offshore with fluctuating water energy and salinity (Pandey et al., 2006a, b; Bhat and Ahmad, 2013; Ahmad et al., 2017). The estimated thickness of the Lathi Formation is 330-360 m (Narayanan et al., 1961; Narayanan, 1964; Pareek, 1975). Based on the lithology and depositional environment, Lathi Formation is sub divided into Lower Odania and Upper Thaiat members (Das Gupta (1975).

Methodology

The methods of the study involved both field study and laboratory analyses. The study of sedimentological characteristics in terms of lithology, texture, sedimentary structures were carried out at both the outcrops and borehole samples. Petro-mineralogical studies have been carried out on 12 surface samples of the Lathi sandstone collected from Rama-Koda area. Thin section study was carried out using petrographic microscope (OLYMPUS BX50) at the petrology laboratory, AMD Jaipur. Geochemical characterization of the sediments was carried out on 133 surface and subsurface samples. Major oxides and trace element analysis of these samples was carried out using "ARL PERFORM'X (Thermo Fisher Scientific)" model of WD-XRF at XRF Laboratory, AMD Jaipur.

Lathi Sandstone

The Rama-Koda area (Fig.2) exposes sandstones as the dominant rock-type with minor siltstones and conglomerates. The beds are generally horizontal to gently dipping (2-5°) towards NW. Sandstones show variation in colour, grain-size and texture. They are medium- to coarse-grained, moderately sorted and the colour variations include red, reddish brown, brown, purple, grey, maroon and yellow. The conglomerates belong to the Odania Member of Lathi Formation and contain pebbles of quartz, jasper, chert, basic rocks, etc. of various sizes (<4 cm). The siltstones are grey and occur as thin beds and lenticular bands within sandstones and are at places highly ferruginous. These sandstones are characterised by primary sedimentary structures such as cross-beddings, herringbone cross-stratifications and ripple marks, and secondary structures such as penecontemporaneous deformations, load casts and flame structures. Palaeocurrent directions were measured from cross-beddings, ripple marks, oriented pebbles and oriented petrified plant material which indicated a south-westerly palaeocurrent direction at Rama-Koda area (Fig.3).

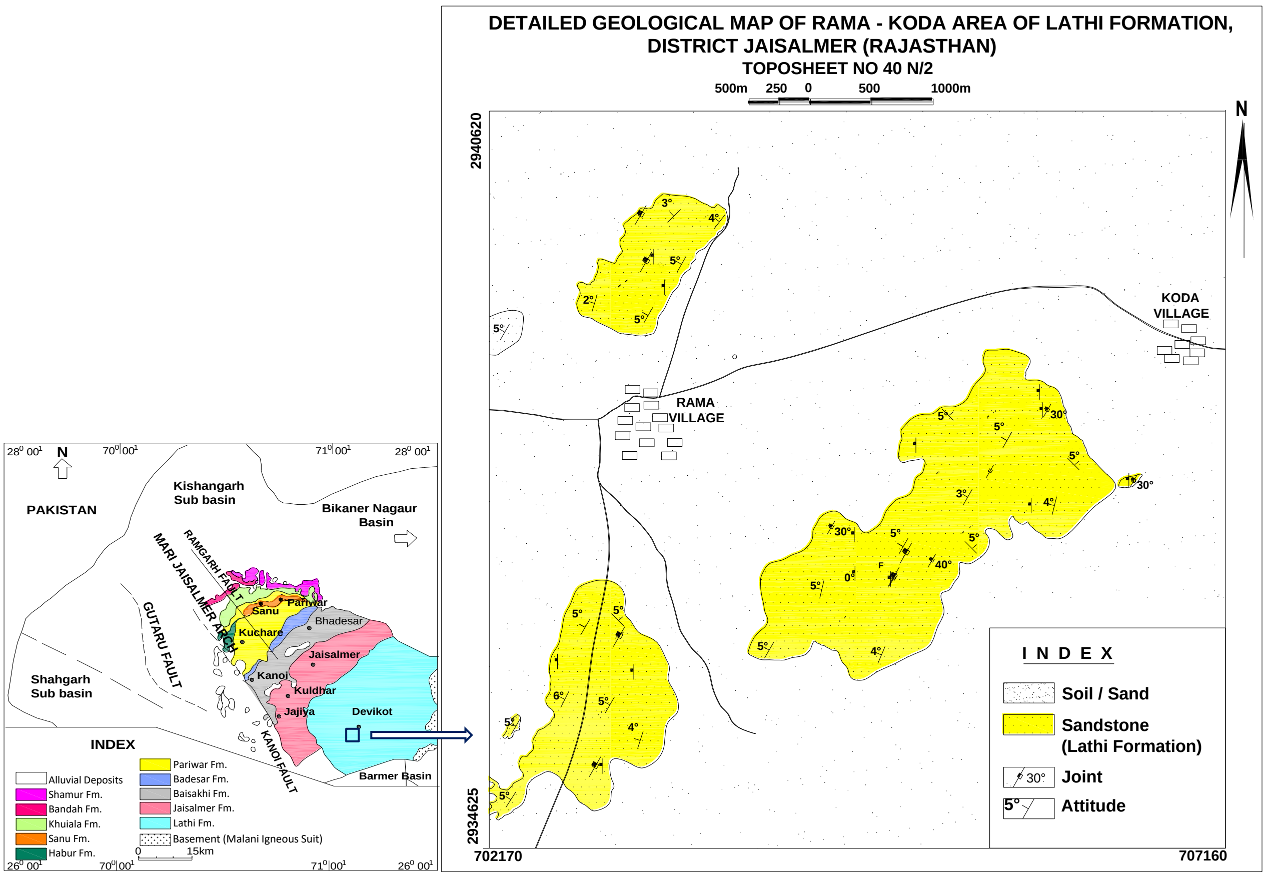

Fig. 2 Geological Map of Rama-Koda area, southern part of Jaisalmer District, Rajasthan

Based on lithological and sedimentological characters of the surface exposures as observed in road cutting and *nala* sections, four sedimentary facies were identified viz. a) Planar-laminated sandstone, b) Cross-bedded sandstone, c) Alternating siltstone and fine-grained sandstone and d) Conglomerate. Planar laminated sandstones are fine- to medium-grained, yellow to brown in colour with grain supported fabric and are moderately to well sorted. Cross-bedded sandstones are medium- to coarse-grained, moderately sorted, pale yellow to red and buff to brown in colour, often ferruginous and friable. They display sedimentary structures such as planar and trough cross bedding, ripple marks and contains petrified plant material occasionally. Alternating siltstone and fine-grained sandstone unit is composed of dark-greyish and pale yellow coloured, well-sorted siltstone and very fine grained silty sandstone. Conglomerate facies unit is matrix-supported, and comprises of numerous silicified and ferruginised petrified plant matter.

The sub-surface exploration carried out by AMD in Rama-Koda area intercepted four major sedimentary units, i. e., fine- to medium-grained yellowish to reddish sandstone (SST-1), shale, medium- to coarse-grained, reddish to brownish sandstone (SST-2) and carbonaceous pebbly sandstone (Peb. SST).

Texturally the sandstone appears immature to moderately mature. The water table invariably occurs at 150-165m depth in boreholes. The pebbly sandstone occurring below water table is grey to off-white, coarse-grained to pebbly in nature and comprises of carbonaceous matter, lignite/coal with specks of pyrite. This pebbly sandstone unit is observed in the boreholes drilled between Rama in west to Dangri (Malani granite and rhyolite are in close proximity) in the east covering 40 km.

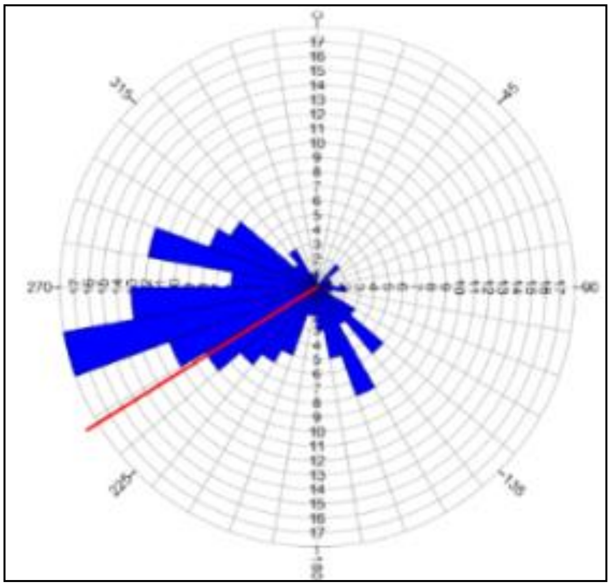

Fig. 3 Ross diagram showing the palaeocurrent direction of Lathi sediments at Rama-Koda area

Petro-mineralogical Studies

The Lathi sandstone is medium- to coarse-grained, moderately sorted and comprises of quartz, microcline, orthoclase, muscovite, lithic fragments including chert, quartzite (Fig.4a) and acidic volcanics and heavy minerals. The clasts are bound by hematite, hydrous iron oxide minerals and calcite cements (Fig.4b). Replacement of calcite by hematite indicates the late diagenetic activity. Rutile and zircon are the main heavy detritus, which together constitute 5% of the total clasts (Fig.4c). Quartz clasts are dominantly monocrystalline with undulose extinction indicating their derivation from deformed plutonic igneous provenance. In addition, the non-undulated quartz with straight extinctions in the Lathi sandstone might have derived from volcanic source. This is supported by bipyramidal six sided quartz crystals (Fig.4d). Thus, the clasts consisting of mildly deformed monocrystalline quartz, undeformed euhedral quartz and lithic fragments of rhyolite (Fig.4e) are inferred to have been derived from volcano-plutonic rocks of the Malani Igneous Suite (MIS) and older granites. Presence of volcanic clasts indicates that a source for uranium existed in hydrologic continuity with the host sandstone (Adams and Cramer, 1985). Polycrystalline quartz includes strained, sutured grains indicating a metamorphic source. A minor fraction of the clasts is constituted by quartzite and sheared quartzite (Fig.4f), which indicates that metasedimentary rocks have also contributed and formed the provenance for the sandstones. Zircon is identified as the main radioactive mineral which is present as minor detritus. It constitutes approximately 1% of the total clasts in sandstones and in some cases occurs as thin lamellae. Minor amount of monazite is also identified.

Geochemistry

A total of 133 surface and subsurface samples of the Lathi sandstone from southern part of the Jaisalmer Basin were analysed for major oxides and trace elements (V, Cr, Co, Ni, Cu, Zn, Ga, Rb, Sr, Y) (Table 2). All the samples contain high SiO_2 (56.73% to 95.63%) with an average of 85.94% being higher than the post Archaean Australian Shale (PAAS) (62.80%) and Upper Continental Crust (UCC) (66.00%) (Taylor and McLennan, 1985). SiO_2 shows negative correlation with other major elements. This negative correlation might be because most of the silica being sequestered in quartz (Osman, 1996) and it suggests mineralogical maturity of the sandstones. The average K_2O/Al_2O_3 ratio of the Lathi sandstones is 0.025, which indicates the preponderance of alumina rich clay minerals over K- feldspars and micas (Cox et al., 1995). High concentration of Fe_2O_3 suggests that a part of the Fe_2O_3 was possibly precipitated as goethite/limonite during sedimentation and diagenesis. SiO_2 in the Lathi sediments does not show any relation with CaO, thus indicating the presence of secondary carbonates in the total CaO (Feng and Kerrich, 1990). Values of Al_2O_3/TiO_2 ratio of the sandstones are high (av. 22.98) and indicate derivation of the detrital material from a continental source (Fyffe and Pickerill, 1993).

In log (SiO_2/Al_2O_3) versus log (Na_2O/K_2O) plot after Pettijohn (1975), majority of the samples straddle in sub-arkosic field (Fig.5). The values of Chemical Index of Alteration (av. 80.45), Chemical Index of Weathering (av. 85.23) and Plagioclase Index of Alteration (av. 84.23) indicate a moderate to high degree of chemical weathering. In binary plot of SiO_2 vs (Al_2O_3 + K_2O + Na_2O) (Suttner and Dutta, 1986), majority of the sandstones plot in the field of humid to semi-humid climate with a notable proportion of samples indicating arid climate (Fig.6). Al_2O_3/TiO_2 ratios of the studied samples (6.2 to 48.8) suggest a geochemical signature of both intermediate and felsic igneous source rock. Location of the samples in the TiO_2 vs Zr scatter plot

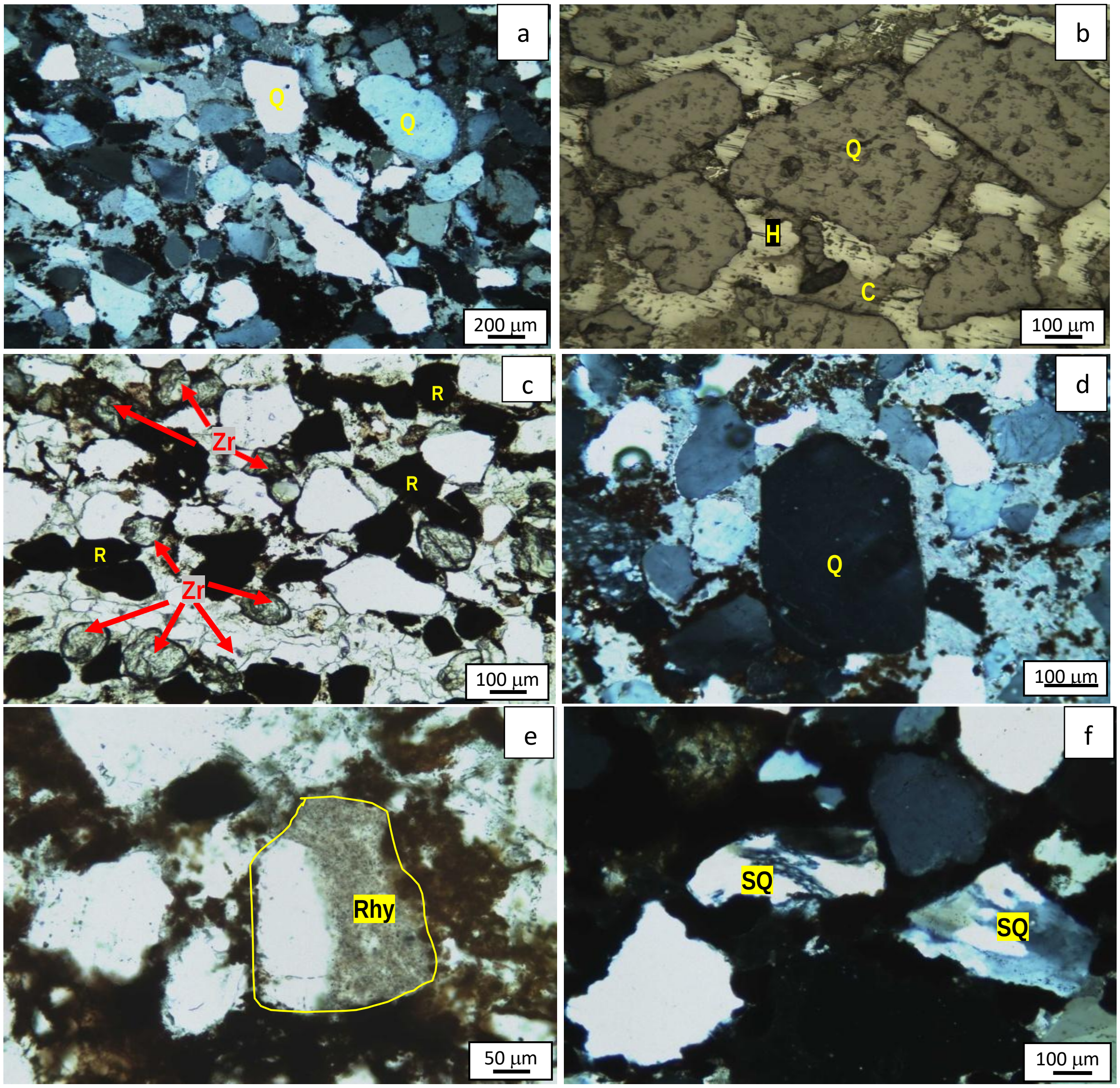

Fig 4 a. Fine grained closely packed clastic framework in calcareous sandstone; b. Coating of hematite (H) around quartz grains (Q) in sandstone; c. Rutile (R) having opaque grains and zircon (Zr) grains present as thin lamellae in sandstone; d. Bipyramidal quartz crystal of volcanic origin in sandstone; e. Fragment of rhyolite (Rhy) comprising quartz phenocryst and microcrystalline groundmass in sandstone; f. Rock fragments of sheared quartzite (SQ) in sandstone.

(Hayashi et., 1997) confirm geochemical signature of a provenance comprising of felsic igneous rock (Fig.7). In the SiO_2-K_2O/Na_2O discrimination diagram (Roser and Korsch, 1986), most of the samples straddle in the passive margin field (Fig.8),

Gravity data and Bouguer anomalies

The Bouguer gravity image clearly depicts the basement topography (anomaly ranging from -4.8mGal to 1.7m Gal) in southern part of the Lathi Sub-basin around Rama-Koda- Bakhrani sector, Jaisalmer district. The negative gradient of regional anomaly from SE of Rama to NW of Sethodi villages indicates that the general slope of the basement is towards NW. The high gravity signature near Rama village is attributed to basement upliftment and low gravity signatures represent the basement depressions, where thick pile of sediments have been deposited (Fig.9). Power spectrum analysis helped in estimating the average depth to the basement as 800m, 400m and 250m in North West, central and south eastern parts of the study area. Major structural features such as fractures and faults have been identified based on the gravity gradient patterns and anomaly variations.

Table 2: Geochemical data of Lathi sandstones from southern part of Jaisalmer Basin

	Subsurface Sandstone												Surface Sandstone (n=15)			
	SST-1 (n=42)				SST-2 (n=32)				Peb. SST (n=44)							
	Min	Max	Mean	Std. Dev	Min	Max	Mean	Std. Dev	Min	Max	Mean	Std. Dev	Min	Max	Mean	Std. Dev
SiO_2 (wt.%)	63.54	94.42	87.12	7.32	57.64	95.63	83.71	10.25	76.42	94.96	89.47	3.94	56.73	91.22	80.83	9.23
TiO_2 (wt.%)	0.10	1.04	0.36	0.26	0.09	1.04	0.53	0.27	0.05	0.97	0.28	0.16	0.14	1.52	0.61	2.29
Al_2O_3 (wt.%)	2.25	16.80	5.60	2.85	2.01	18.69	7.75	6.07	0.91	15.08	5.67	3.65	2.05	17.37	6.45	2.70
Fe2O_3T (wt.%)	0.90	10.66	2.71	2.02	1.08	13.94	3.79	4.72	1.20	12.06	2.71	2.01	0.78	16.04	6.02	6.55
MgO (wt.%)	0.04	1.27	0.27	0.29	0.04	0.91	0.22	0.20	0.04	1.43	0.20	0.27	0.07	0.66	0.31	0.20
MnO (wt.%)	0.01	0.23	0.02	0.03	0.01	0.61	0.04	0.10	0.01	0.49	0.03	0.08	0.02	0.53	0.11	0.14
CaO (wt.%)	0.06	6.71	1.23	1.58	0.05	1.13	0.20	0.21	0.04	8.12	0.65	1.37	0.10	11.81	2.11	1.39
Na_2O (wt.%)	0.08	1.77	0.41	0.37	0.08	1.59	0.43	0.28	0.11	2.45	0.38	0.35	0.06	1.18	0.53	0.39
K_2O (wt.%)	0.05	1.89	0.45	0.38	0.03	1.80	0.49	0.50	0.08	3.23	0.57	0.64	0.01	0.53	0.15	0.07
P_2O5 (wt.%)	0.02	0.11	0.06	0.02	0.03	0.47	0.08	0.07	0.02	0.10	0.05	0.02	0.01	0.09	0.06	0.02
V (ppm)	17	75	38	16	17	85	48	19	16	65	33	10	20	108	54	21
Cr (ppm)	31	254	67	40	21	552	76	84	27	317	57	40	40	197	74	32
Co (ppm)	5	34	9	6	5	71	13	12	5	31	8	5	5	63	21	17
Ni (ppm)	15	68	24	8	17	78	33	13	16	55	27	9	6	57	20	10
Cu (ppm)	6	24	12	4	5	37	15	7	5	22	12	3	8	16	10	1
Zn (ppm)	24	121	50	15	41	125	63	17	30	97	58	16	21	67	33	14
Ga (ppm)	10	22	16	2	8	24	17	3	11	21	16	1	7	20	13	3
Rb (ppm)	34	79	48	10	28	137	55	18	34	149	55	22	24	56	38	7
Sr (ppm)	24	129	52	29	22	116	49	24	18	243	41	36	11	102	44	26
Y (ppm)	5	35	10	6	5	28	11	6	5	27	9	4	8	41	22	12
Zr (ppm)	39	384	155	75	67	349	186	65	22	195	127	33	49	1816	465	731
Nb (ppm)	8	70	40	15	8	62	39	10	5	59	35	10	19	158	52	31
Ba (ppm)	28	197	77	41	25	359	122	71	31	238	80	41	25	362	141	93
La* (ppm)	25	150	75	45	25	343	86	75	26	132	51	39	45	305	143	64
Ce* (ppm)	27	241	92	66	37	396	110	85	32	225	77	70	30	1023	243	115
Pb (ppm)	22	63	47	8	32	65	52	7	22	66	48	6	5	54	33	14
CIA	52.20	94.78	78.80	9.80	65.55	92.62	85.39	5.60	63.20	94.32	80.90	6.00	60.31	95.87	85.86	5.40
PIA	52.93	97.96	83.20	9.00	66.82	96.22	88.67	5.60	66.30	94.20	85.50	5.00	59.50	95.80	85.85	6.20
CIW	56.44	98.08	78.82	9.00	68.22	96.38	89.23	5.40	69.42	94.45	86.60	5.00	60.31	95.87	85.86	5.60

SST-1: Fine to medium grained yellowish to reddish sandstones

*SST-2: Medium to coarse grained, reddish to brownish sandstone; Peb. SST: Pebbly sandstone; *semi-quantitative data*

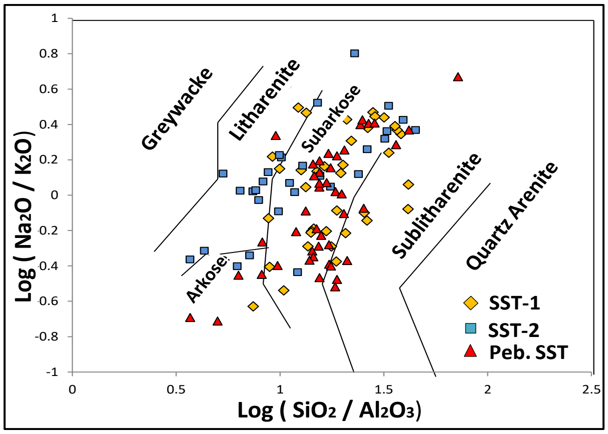

Fig. 5: Log (SiO_2/Al_2O_3) vs log (Na_2O/K_2O) plot (Pettijohn, 1975).

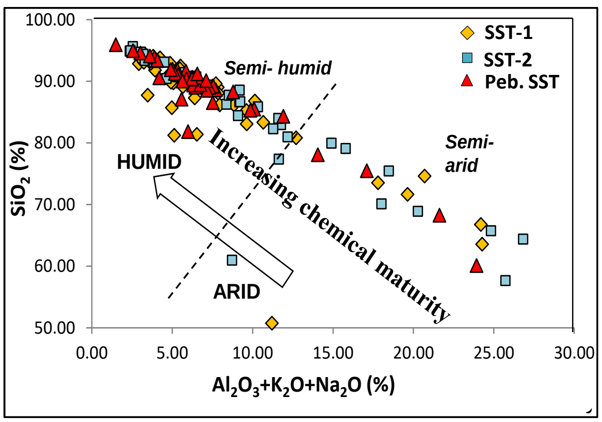

Fig. 6: SiO_2 vs (Al_2O_3 + K_2O + Na_2O) bivariate diagram (Suttner and Dutta, 1986). It indicates humid to semi-humid climatic condition at the time of deposition and increased chemical maturity of the sandstone.

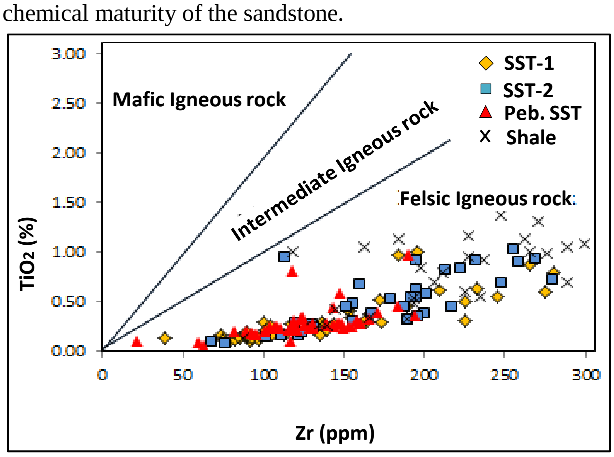

Fig. 7: TiO_2 versus Zr bivariate diagram (Hayashi et al., 1997), indicating geochemical signature of a provenance comprising felsic igneous rock.

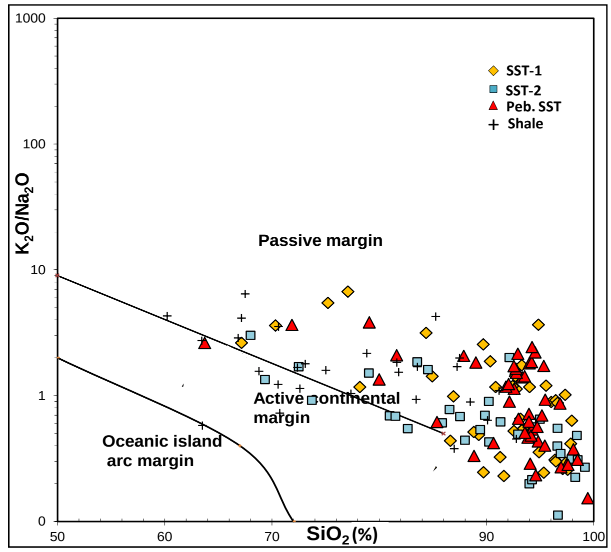

Fig. 8: SiO_2 versus K_2O/Na_2O discrimination diagram (Roser and Korsch 1986) indicating the deposition of Lathi sediments in passive margin tectonic setting.

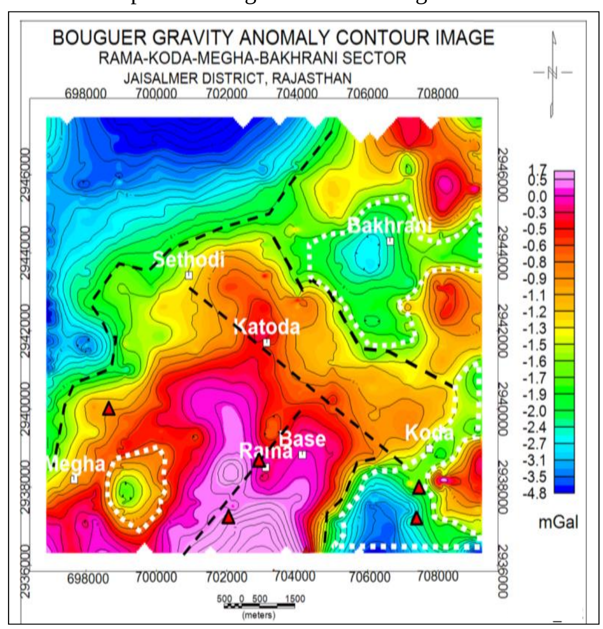

Fig. 9: Bouguer gravity anomaly contour image, Rama-Koda-Megha-Bakhrani sector, Jaisalmer District, Rajasthan

Discussion

In the present study, sedimentological, petro-mineralogical and geochemical studies have resulted in the interpretation of depositional environment, provenance, source area weathering, tectonic setting and rock classification. The Lathi sediments have been deposited in fluvial to marginal marine conditions as evidenced from medium- to coarse-grained, moderately sorted sediments, occurrence of ripple laminations, cross- and herringbone cross stratifications. Geochemical characters of the Lathi sediments depict felsic igneous rocks as the provenance. The heavy mineral assemblage of zircon, monazite and xenotime indicate acid igneous rocks as provenance. Further, the metamorphic provenance is supported by the presence of garnet and rutile. Petrographic studies reveal the presence of clasts and lithic fragments of rhyolites and sheared quartzite in sandstones and suggest that Malani Igneous Suite of rocks and metasedimentary rocks of the Aravalli craton have acted as the provenance of the Lathi sediments in the study area. Malani rhyolites and granites are rich source for uranium, containing 6.7 ppm and 9.2 ppm average intrinsic uranium respectively (Jain et al., 1998).

The rocks of the Lathi Formation have a NE-SW strike with very low dip (2-5°) towards NW. A westerly palaeocurrent direction is interpreted for the Lathi sediments in the study area.

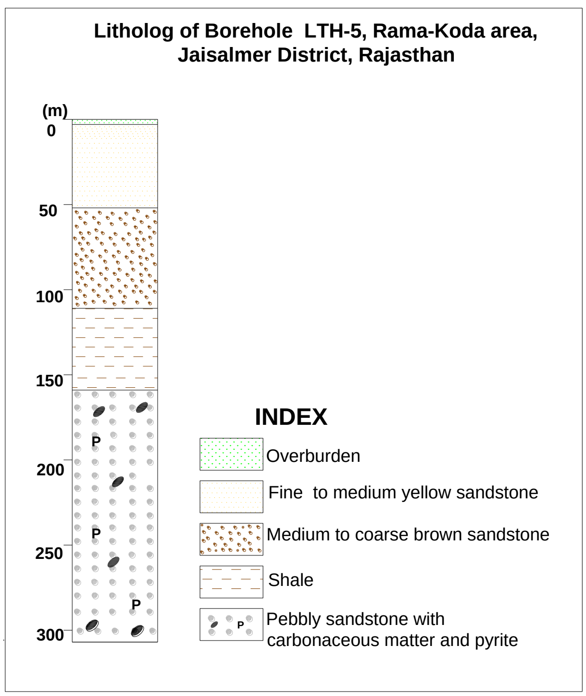

Fig.10: Litholog of borehole LTH-5 drilled at Rama-Koda area, Jaisalmer district, Rajasthan

The Bouguer gravity image and modelling studies has clearly depicted the north-westward slope of the basement topography. Weathering indices suggest a moderate to high degree of weathering of the source rocks and a passive margin as the tectonic setting are interpreted for sandstones in the study area. The pebbly sandstone horizon occurs below the water table and contains carbonaceous matter and pyrite, suggests prevalence of reducing conditions during deposition (Fig.10). The Lathi sediments in the study area also contain huge amounts of petrified plant materials. The petrified wood samples (n=12) analysed showed 5- 39ppm eU_3O_8, <5-34 ppm eU_3O_8 (Ra) and <10-11 ppm ThO_2. Predominance of plant fossils in the Lathi sediments in Rama-Koda area suggest humid palaeoclimate conditions. Sandstone-type uranium deposits are commonly epigenetic concentrations of uranium occurring as uneven impregnations in sandstones and at places in conglomerates and finer grained inter-beds (Finch and Davis, 1985). The host-rocks are permeable, fairly well-sorted, unmetamorphosed clastic sediments ranging from mudstone to conglomerate, but fine- to medium-grained sandstones are the dominant hosts (Finch and Davis, 1985).

Exploration activities carried out by AMD over the last two decades, resulted in locating several surface radioactive anomalies associated with the Lathi sediments. The radioactive anomalies located at Dabla, Akal, Jodha, Rama, Koda, Megha, Narsingh Ki Dhani, Kita, Javandh, Jogidas Ka Gaon, Modha, Pithodai, Bombai hill and Bakhrani areas are associated with ferruginised sandstones and to some extent with conglomerates.

Conclusion

The Lathi Formation exhibits several favourable factors for hosting 'sandstone type' uranium mineralization such as its Jurassic age, arkosic composition of sediments, low dipping beds, fertile provenance, continental to marginal marine depositional environment, intercalation of sandstones with shale/mudstone, occurrence of reducing agents as carbonaceous matter, lignite and pyrite. Sandstone type uranium deposits dominantly occurs in Silurian and younger host rocks, which reflects the initial and continued development of vascular land plants. Thick sequences of sandstone interbedded with shale/ mudstone and low dipping beds favours prolonged and focused ground water flow. Framework mineralogy and geochemical characterization reveals a mixed provenance of the Lathi sediments containing metamorphic rocks of Aravalli craton and felsic igneous rocks, which are fertile source for uranium. Arkoses and sub-arkoses contain stable clasts (quartz and feldspar) which help to retain sediment permeability and suggest its derivation from proximal uplifted basement rocks which could facilitate high ground water flow (Adams and Cramer, 1985). The humid to semi-humid climatic condition prevailed during the sedimentation which afforded abundant plant material that was deposited in the potential uranium host rocks. Uranium occurrences located in the Lathi sediments so far, are associated with oxidized sandstones on the surface. The present study reveals reduced nature of the Lathi sediments below water table as depicted from subsurface exploration. Presence of lignite, pyrite and carbonaceous matter in the coarse grained pebbly sandstone below the water table favours the reduction of uranium from the oxidized ground waters. Though, present subsurface exploration could not record significant uraniferous occurrence, the Lathi Formation spreads over 900 sq.km area with extensive surface and subsurface persistence, provides ample scope for further subsurface exploration.

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