IJISET - International Journal of Innovative Science, Engineering & Technology, Vol. 1 Issue 6, August 2014.
www.ijiset.com
ISSN 2348 – 7968

A note on assemblage of heavy minerals from the Tertiary sediments of the Jaisalmer basin, Rajasthan, India.

Suyog A. Jagtap

Department of Civil Engineering, JSPM Narhe Technical Campus (University of Pune),
Pune-411041, Maharashtra, India

Abstract

Heavy minerals are high density accessory mineral constituents of terrigenous (outcrop)/slici-clastic rocks, which are characterized by having a specific gravity greater than 2.89 (Bromoform) or 2.96 (Tetrabromoethane). The presences of heavy minerals lead to the derivation of source rocks.

The Tertiary sediments of the Jaisalmer basin constitute of four formations namely Sanu, Khuiala, Bandah and Shumur Formations, whereas shumur Formation is sub-surface. In view of this, present analysis gives a look on heavy mineral crops found in the sediments from the surface formations i.e. Sanu, Khuiala and Bandah Formations and indicative of their source of information. Total ten verities of heavy minerals are documented starting from tourmaline, zircon, rutile, garnet, staurolite, epidote, monazite, apatite, kyanite and hornblende.

Keywords: *Heavy mineral, Tertiary, Jaisalmer basin, Rajasthan, India.*

1. Introduction

The heavy mineral analysis is one of the most important and widely used techniques in determination of the provenance studies in today's world; it has been more than 10 decades since the study of heavy minerals was established. Heavy minerals are extremely sensitive indicators of basinal processes and source area lithology (Morton, 1985; Stattegger, 1987) because it provides wider spectrum of silicates, oxides, sulphates and phosphates than lighter minerals (Masroor Alam, 2002). The heavy mineral data is used conjunction with microprobe analysis; it provides sensitive information on the mineralogical composition of sediments source rocks (Morton, 1991; Morton and Hallsworth, 1999). The heavy mineral studies on modern basins have provided actualistic analogues which leads to a better understanding of the geological history of their ancient counterpart (Mange and Maurer, 1992). Lithostratigraphically, the rocks of the Jaisalmer Basin are broadly categories into Mesozoic and Tertiary formations. The given paper attempts to study of heavy minerals assemblage which derived from the sediments of tertiary successions of the Jaisalmer basin, Rajasthan.

2. Methodology

Samples were systematically collected from all three formations of Tertiary age exposed in the part of Jaisalmer basin, namely Sanu Formation, Khuiala Formation and Bandah Formation. More than 15 sample were considered for heavy mineral analysis (Gravity – settling in bromoform) from respective members of each formation. The samples were disaggregated by using agate mortar, later disaggregate material is subjected to sieving by using 230 mesh. After sieving acid treatment is given to the sample by using 10% dilute hydrochloric acid to removing mineral stain and calcium carbonate and then unnecessary material is decanted and sample is kept in the oven for drying. After that sample is performed for actual heavy mineral separation by means of high-density liquid i.e. bromoform (Sp.gr. 2.89), then obtained heavy mineral suites were mounted on the glass slide by using Canada balsam and the heavy mineral slides were prepared.

3. Geology of the area

The Jaisalmer Basin characterized by the eastern shelf part of large Indus Basin, Jaisalmer Basin is a Pericratonic shelf extended towards west, dipping eastern flank of Indus Basin, bounded by Divikote-Nachna uplifts towards east and south east, while Fatehgarh fault marked by its southern limit. The Malani igneous Suite of Pre-Cambrian age and metamorphic rocks constitutes the basement for the Jaisalmer Basin.

Geologically, the Mesozoic rocks of Jaisalmer area is represented by limestone, shale, siltstone and sandstone and have been subdivided into six formation (Fig.1), namely Lathi Formation, Jaisalmer Formation, Baisakhi Formation, Bhadasar Formation, Pariwar Formation and Habur Formation respectively (Das Gupta, 1975; Swami Nath et. al., 1959). The Lathi Formation is sited as the

ISSN 2348 – 7968

oldest stratigraphic succession in the area, which is superimposed by the Precambrian basement rocks of Malani Igneous Suite towards Pokaran (Torsvik et al. 2005) and the sandstone of the Lathi Formation is documented as the oldest Mesozoic unit in the Jaisalmer Formation (Pareek 1984; Singh 1999). The Tertiary succession is marked by a contact with Mesozoic rocks comprises of dirty yellow to reddish colored, coarse grained sandstone as well as fossiliferous limestone which are group into three formations, namely Sanu, Khuiala and Bandah Formations. Based on the subsurface data Khuiala Formation was earlier defined as the Laki Formation (Sigal et al, 1971; Das Gupta, 1974; Singh, 1976). The contact between Mesozoic and Tertiary rocks is unconformable and demarcated along the southeast and northwest of Sanu and Habur village respectively (Das Gupta, 1975; Singh 1996).

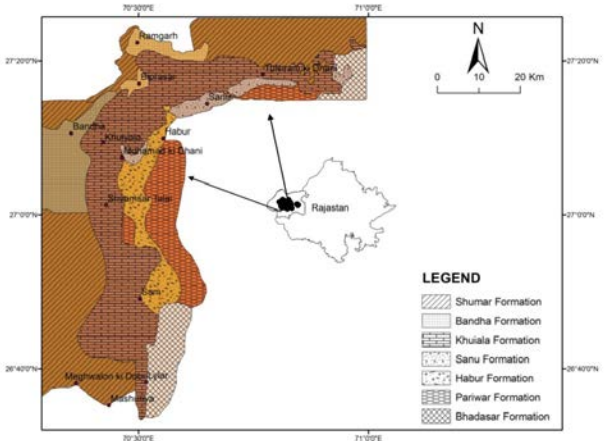

Fig.1:- Geological map showing Tertiary Formations of the Jaisalmer Basin. (after Bafna and Dhaka, 1999; Roy and Jakhar, 2002)

4. Systematic description of heavy minerals

There are total ten types of heavy minerals are found, named as Tourmaline, Zircon, Rutile, Garnet, Staurolite, Epidote, Monazite, Apatite, Kyanite and Hornblende from the locality of Sanu, Khuiala and Bandah Formations. In general, the tourmaline grains are brownish, greenish brown and rarely blue in colored and mostly sub-rounded, euhedral to sub-hedral in forms. Zircon is found as colorless to pink in colored and exhibiting prismatic, elongated, euhedral to sub-hedral forms with inclusions some other minerals and opaque's. The wine-red colored rutile showing elongated, rounded to sub-rounded form can also be observed. The colorless to pink variety of garnet is found as well-rounded to sub-rounded grains with inclusions of opaque and some other minerals. The other heavy minerals crop is includes rounded to sub-rounded, elongated grains of golden yellow colored staurolite, greenish hornblend, apatite, epidote, monazite and kyanite exhibits typical bladed form. After the identification of each heavy mineral from all prepared slides, the formation/member wise modal analysis was carried out and the obtained data is as given below and it is graphically also represented by using Pi-diagram.

Sanu Formation:-

Two samples were analyzed to obtain the heavy mineral suite from the Sanu Formation. On the basis of obtained data after modal analysis the heavy mineral crop of samples of the Sanu Formation (Fig.2) mainly consists of tourmaline which varies from (16.68 – 21.59%), zircon (14.28 – 18.18%), rutile (06.81 – 07.81%), garnet (12.08 – 14.77%), staurolite (07.95 – 09.89%), epidote (09.09 – 10.98%), monazite (04.39 – 04.54%), apatite (06.81 – 08.79%), kyanite (10.22 – 10.98%), and hornblende (02.19%).

Khuiala Formation:-

The Khuiala Formation is divided into four members namely, lowermost Khuiala Scarp Member, Sirhera Member, Te Takkar Member and Hingola Member. Two samples were prepared for heavy mineral analysis from each member except Hingola Member as it consists of pure white limestone.

On the basis of obtained data after modal analysis the heavy mineral crop of samples of the Khuiala Scrap Member (Fig.4) mainly consists of tourmaline which varies from (19.78 – 28.00%), zircon (13.18 – 16.80%), rutile (06.40 – 06.59%), garnet (10.98 – 12.00%), staurolite (01.09 – 04.80%), epidote (09.60 – 17.58%), monazite (06.40 – 12.08%), apatite (08.80 – 09.89%), hornblende (02.40 – 04.39%), and kyanite (04.39 – 04.80%).

The heavy mineral crop of samples of the Sirhera Member (Fig.5) mainly consists of tourmaline which varies from (22.01 – 24.56%), zircon (13.15 – 16.51%), rutile (06.42 – 08.77%), garnet (13.76 – 14.03%), staurolite (02.63 – 04.58%),epidote(11.40–14.67%),monazite(04.58–7.89%), apatite (09.64 – 12.84%), hornblende (01.83 – 03.50%), and kyanite (02.75 – 04.38%).

The heavy mineral crop of samples of the Te Tekkar Member (Fig.3) mainly consists of tourmaline which varies from (24.46 – 27.19%), zircon (20.17 – 20.86%), rutile (12.18 – 12.23%), garnet (10.07 – 10.52%), staurolite (03.50 – 04.31%), epidote (07.01 – 07.91%), monazite (06.26 – 06.47%), apatite (07.89 – 08.63%), hornblende (02.63 – 03.59%), and kyanite (01.43 – 03.49%).

ISSN 2348 – 7968

Bandah Formation:-

The rock of Bandah Formation is exposed in two members viz. lower Habib Rahi Member and Bakri Tibba Member. Two samples were analyzed from each member to obtain the heavy minerals crop.

On the basis of obtained data after modal analysis the heavy mineral crop of samples of the Habib Rahi Member (Fig.7) of Bandah Formation is mainly consists of tourmaline which varies from (12.25 – 15.66%), zircon (08.57 – 13.25%), rutile (05.71 – 10.84%), garnet (19.27 – 25.71%), staurolite (01.42 – 03.61%), epidote (07.14 – 07.22%), monazite (04.28 – 04.81%), apatite (08.43 – 10.00%), hornblende (04.28 – 04.81%), and kyanite (12.04 – 20.00%).

The heavy mineral crop of samples of the Bakri Tibba Member (Fig.6) mainly consists of tourmaline which varies from (13.25 – 13.84%), zircon (09.23 – 10.84%), rutile (04.81 – 07.69%), garnet (16.92 – 18.07%), staurolite (03.07 – 03.61%), epidote (09.23 – 09.63%), monazite (06.02 – 06.15%), apatite (10.76 – 10.84%), hornblende (00.42 – 00.85%), kyanite (18.46 – 20.48%).

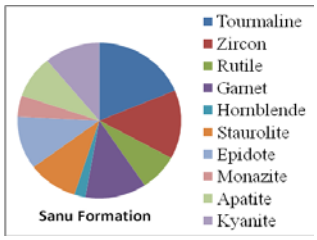

Fig.2

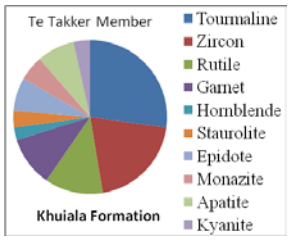

Fig.3

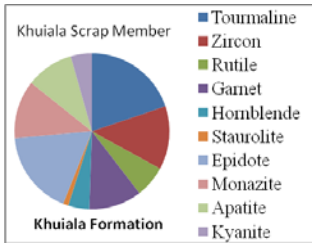

Fig.4

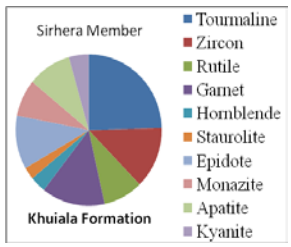

Fig.5

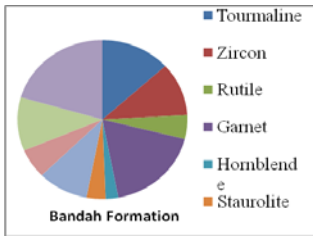

Fig.6

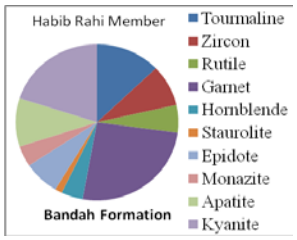

Fig.7

4. Conclusions

The heavy minerals are responsive markers of basinal processes and identifying provenances (Morton, 1985; Stattegger, 1987). Form the present studies it can be observed that within heavy minerals there is a dominances tourmaline, zircon and garnets and then rest of them. Specifically tourmaline is the most abundant amongst the all, which are green, yellowish brown and bluish in colored within yellowish brown colored tourmaline are indicative of their source from metamorphic rocks whereas bluish and green colored are typical from granites, shape of the grains indicating that they are from first cycle as well as poly cycle sources. The second most abundant mineral zircon is found as colorless, pink and brownish in color and few have them shows zoning, the shape of the zircon is varies from prismatic, euhedral to sub-hedral, within pink as well as zoned one verity of zircon suggests granitic source whereas colorless zircon suggest their origin from felsic igneous rocks. Garnets can be observed as colorless to pink in colored and few brown colored can also be observed within colorless to pink verity suggestive of their source from marble while brown one indicative of medium to high grade gneiss and schist. The presences of wine red colored rutile suggest their origin from high grade metamorphic rocks, perhaps amphibolites. The occurrences of minor amount of other minerals starting from epidote, staurolite, apatite, kyanite, hornblend, olivine and monazite are typically indicative of medium to high grade metamorphic source rocks as well as from magmatic origin.

The overall assemblages of heavy minerals signify that these minerals are derived from rocks of magmatic origin particularly granite and its derivatives as well as mafic and felsic igneous rocks to high-grade metamorphic rocks (Morton, 1985; Stattegger, 1987 and Mansoor, 2002). Alternatively it can also be suggestive of intracratonic basinal setup receiving sediments from meta-sedimentary rocks of a recycled orogenic provenance.

Acknowledgments

The authors are greatly thankful to the Head, Postgraduate Department of Geology; RTM Nagpur, University for providing facilities in present work and also greatly thankful to Management, Director and Dean, JSPM Narhe Technical Campus, Pune for constant encouragement during the preparation of manuscript.

ISSN 2348 – 7968

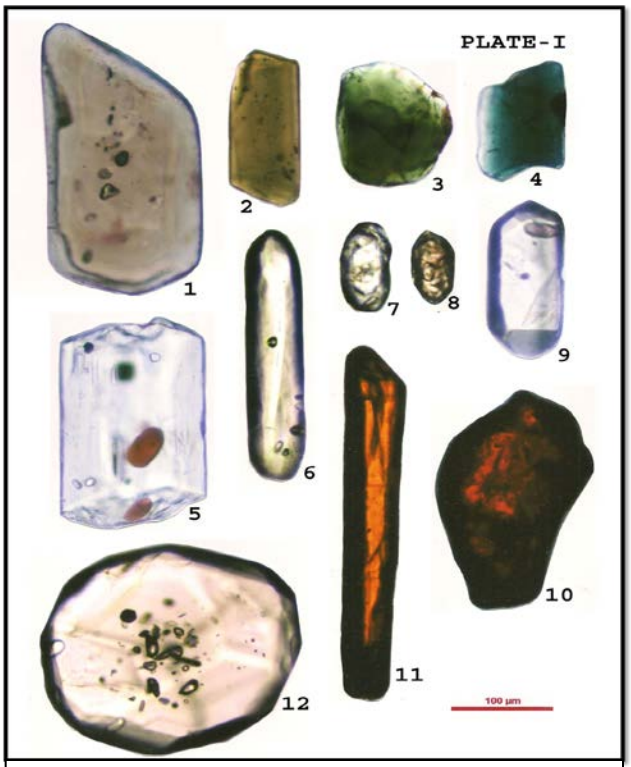

Fig.8: 1-4:- Tourmaline (brown, greenish brown, green, blue), 5-9:- Zircon (colorless & pink), 10-11:- Rutile (wine red) and 12:-

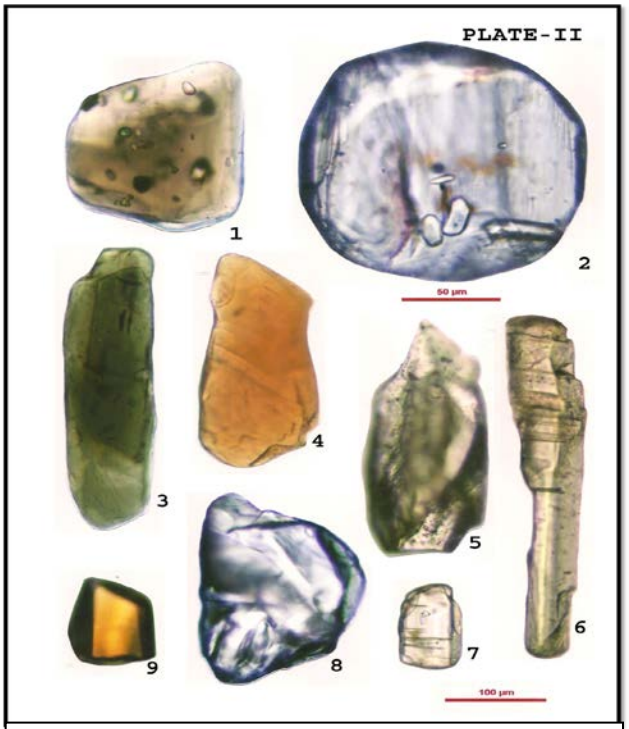

Fig: 9, 1-2:- Garnet (brown & pink), 3:-Hornblend, 4:- Staurolite (golden yellow), 5:-Epidote, 6-7:- Kyanite, 8:- Apetite and 9:- Monazite (honey yellow)

References

Bafna, P.C. & Dhaka, B.S. 1999. *Industrial grade limestone deposits of Tertiary period in Western Rajasthan*. In: B.S. Paliwal (ed.), *Geological Evolution of Northwestern India*, Scientific Publishers (India), Jodhapur, 210-215.

Das Gupta, S.K. 1974. Stratigraphy of western Rajasthan shelf: Proceeding IV Indian Colloquium on Micropaleontology and Stratigraphy, Dehradun, India, 219-233.

Das Gupta, S.K. 1975. Revision of the Mesozoic-Tertiary stratigraphy of the Jaisalmer Basin, Rajasthan. *Indian Journal of Earth Science*, 2(10), 77-94.

Mange, M.A. and Maurer, H.F.W. 1992. *Heavy Minerals in Color*. Chapman and Hall, London, 147.

Mansoor Alam, M. 2002. Generic provenance, tectonics and petrofacies evolutionof the sandstones, Jaisalmer Formation (Middle Jurassic), Rajasthan, *Journal Geological Society India*, 59, 47-57.

Morton, A.C. 1985. A new approach to provenance studies: electron microprobe analysis of the detrital garnet from Middle Jurassic sandstone of the Northern North Sea. *Sedimentology*, 32, 553-566.

Morton, A.C. 1991. Geochemical studies of detrital heavy minerals and their application to provenance studies. In: Morton A.C., Todd, S.P., Haughton, P.D.W. (Eds.), Developments in Sedimentary Provenance Studies. *Special Publication Geological Society of London*, 57, 31–45.

Morton, A.C. & hallsworth, C.R. 1999. Processes controlling the composition of heavy mineral assemblages in sandstones. *Sedimentary Geol*ogy, 124, 03-29.

Pareek, H.S., 1984. Pre-Quaternary geology and mineral resources of north-western Rajasthan. *Memoir Geological Survey of India*, 115, 1-99.

Roy, A.B. & Jakhar, S.R. 2002. *Geology of Rajasthan (Northwest India): Precambrian to Recent*, Scientific Publishers (India), Jodhapur, p. 421.

Sigal, J., Singh, N.P. & Lys, M. 1971. The Paleocene – Lower Eocene boundary in the Jaisalmer area, *Indian Journal Foram. Research*, 1(4), 190-194

ISSN 2348 – 7968

Singh, N.P. 1999. *Relevance of laboratory studies in geological modeling and field geology*, Jaisalmer field guide, ONGC, Dehradun, 1-14.

Singh, N.P. 1996. Mesozoic-Tertiary biostratigraphy and biogeochronological datum planes in Jaisalmer Basin, Rajasthan. In contribution to XVth Indian Colloquium on Micropaleontology and Stratigraphy (eds. Pande, J. et al.), WIGH, Dehradun, 63-89.

Stattegger, K. 1987. Heavy minerals and provenance of sands: Modelling of lithological end members from river sands of northern Austria and from sandstone of the austroalpine Gosau Formation (late Cretaceous). *Journal of Sedimentary Petrology*, 57, 301-310.

Swami Nath, J., Krishnamurthy, J.G., Verma, K.K. & Chandak, G.J. 1959. General geology of Jaisalmer, Rajasthan, ECAFE Symposium, *Mineral Resource and Development Series*, 10, 154-155.

Torsvik, T.H., Pandit, M.K., Redfield, T.F., Ashwal, L.D. & Webb, S.J. 2005. Remagnetization of Mesozoic limestones from the Jaisalmer basin, NW India. *Geophysical Journal International*, 161, 57-64.

First Author Dr. Suyog A. Jagtap, PhD (Geology, 2014), M.Sc. (Geology 2009), B.Sc. (Geology, Physics, Computer Application, 2006). Course on Remote Sensing & GIS Technology & Application from ISRO (2007). Currently working as an Assistant Professor in Department of Civil Engineering, JSPM Narhe Technical Campus Pune. Total Paper published:06, Conference(National/International):05. Faculty Advisor for American Association of Petroleum Geologist Student Chapter.