International Research Journal of Earth Sciences ISSN 2321–2527
Vol. **2(2),** 40-43, March **(2014)** *Int. Res.J. Earth Sci.*

Determination of Sandstone classification by using Geochemical aspect: A Case Study of Garudamangalam Formation, Cretaceous of Ariyalur, Tamilnadu, India

Babu K., Prabhakaran R., Subramanian P. and Selvaraj B.
Department of Earth Sciences, Annamalai University, Annamalainagar-608002, INDIA

Available online at: www.isca.in, www.isca.me
Received 5th February 2014, revised 28th February 2014, accepted 23rd March 2014

Abstract

The composition of sandstone may be expressed in terms of its bulk chemical composition. Such bulk chemical analyses are very useful. To understand fully the geochemical processes and the evolution of various types of sediment or differentiates, chemical analyses needed. Chemical data has value for classification, but the limitations of using chemical data for classification must be identified. The Cretaceous formation of Ariyalur area, Tamilnadu is one of the best developed sedimentary formations in southern India. The staratigraphy of this formation is divided into three groups, Uttatur, Trichinopoly, and Ariyalur. The Trichinopoly group later designated as Garudamangalam Formation. Representative 10 sandstone samples were collected from the Garudamangalam formation, and analysed for major oxide composition by using XRF. The relative concentrations of three major groups- silica, alumina, alkali oxides plus magnesia have been used to classify the Garudamangalam sandstone samples. From the study area samples SiO_2 ranging from (12.93-42.56%), Al_2O_3 (3.49-8.47%), Fe_2O_3(2.29-22.02%) and strongly depleted to S, Na_2O, K_2O, MnO, TiO_2 and P_2O_5. The very high content of CaO ranging from 23.53-45.90%, it indicates they are rich in calcite cement, or it may mean shell fragments in the sandstone particles. Based on the following reference set, guidelines are proposed for chemical classification of sandstones. 1.quartz arenite: $\log(SiO_2/Al_2O_3)\geq1.5$, 2.Greywacke: $\log(SiO_2/Al_2O_3)<1$ and $\log(K_2O/Na_2O)<03$. Arkose(includes subarkose): $\log(SiO_2/Al_2O_3)<1.5$ and $\log(K_2O/Na_2O)\geq0$ and $\log(Fe_2O_3+MgO)/(K_2O+Na_2O)<04$. Lithic arenite: $\log(SiO_2/Al_2O_3)<1.5$ and eighter $\log(K_2O/Na_2O)<0$ or $\log(Fe_2O_3+MgO)/(K_2O+Na_2O)\geq0$. If $\log(K_2O/Na_2O)<0$, lithicarenite can be confused with greywacke. Based on the above guidelines the study area sandstone samples reflects log (SiO_2/Al_2O_3 ratios from 0.47 to 0.92. The log (K_2O/Na_2O) Vs log (Fe_2O_3+MgO)/ (Na_2O+K_2O) scatter diagram shows lithicarenites field. The study area samples reveals that they are rich in Litharenite sediments are evidences of a probable deposition of the felsic rich source rock and deposited in a marine environment.

Keywords: Sandstone, Garudamangalam, classification, lithicarenite and arkose.

Introduction

The cretaceous formation of the Ariyalur area, Tamilnadu is one of the best developed sedimentary sequences in south India. Banerji R.K.[1] was the first to work on the stratigraphy of this formation and he divided the litho-units into three groups: Uttatur, Trichinopoly and Ariyalur. The Trichinopoly Formation redesignated as Garudamangalam Formation. The geology and stratigraphy of this region has been worked out by several workers which includes have redefined the Uttatur Group and identified within it four distinct formations comprising reefoidal bodies, sandyclay, coarse sand bar and gypseferous silty clay unit[2-8]. The Garudamangalam Formation comprises according to Sundaram R. and Rao P.S.[9] he divided into two member Kulakanattam Formation, and Anaipadi Formation. Further[9] classified int Kottarai Member, Anaipadi Member and Kulattur Member. Classified this Formation Kulakanattam Sandstone Member and Anaipadi Sandstone Member. Tewari A.[10] proposed this Formation consist Kulakanattam Sandstone Member, Grey Sandstone Member and Anaipadi Sandstone Member. Tewari A. et al[11] Teredolites froom Garudamangalam Formation. Several workers have worked out this formation in palaeontological aspect only. This paper reveals on Geochemical aspect on this Formation. The Study area map is shown figure-1.

Material and Methods

The Geological field investigation was undertaken mainly along the network of nalla sections of the badland topography which only exposed the Garudamangalam Formation. The attitude of beds, sedimentary structures, lithological variations and other fine sedimentary features are recorded in the field. Around 25 sandstone samples were collected and selected 10 sandstone samples only pulverized and sent to India Cements Limited, R&D center, Dalavoi, Tamilnadu for a geochemical analysis using XRF. Major oxides such as SiO_2, Al_2O_3, CaO, MgO, MnO, Fe_2O_3, S, K_2O, TiO_2, P_2O5 and LOI were obtained (table

1). These oxides were used to calculate the log ratios of $SiO_2/Al_2O_3$and Fe_2O_3/K_2O.

Results and Discussion

The sediments admixed with sandstone during diagenesis are geochemically classified using a sand class system adopted by figure 1. Table 2 shows the log ratios of Fe_2O_3/K_2O Vs SiO_2/Al_2O_3 and CaO values on the sand class. The results of the log ratios and the plotting are matched with the standard pairs of points (table 3) that define the sand class field boundary line. Based on proposed guildelines for use of major oxide ratios to classify sandstone resemble lithic arenites [$\log(SiO_2/Al_2O_3)$] < 1.5. The plotting of log ratios of Fe_2O_3/K_2O against SiO_2/Al_2O_3 in figure 2 show the Garudamangalam sandstone contain sediments that fall within the Litharenite, and wacke classified boundary range values of 0.643-0-89 under SiO_2/Al_2O_3 and 0.5-0.6 under Fe_2O_3/K_2O. Four samples fall into Fe-sand class field boundary suggesting that the mixture of silt and clay-sized quartz, illite and montmorillonite may have intermingled with Fe derived probably from granitic source. Greywacks are lithic fagments that are commonly of fine grained sedimentary and metasedimentary rocks such as mudstone, shale and siltstone and slate and mica schist. The presence of greywacke (Lithic fragment) shows that they are derived from supracrustal rock consistent with granitic basement. The log ratio of SiO_2/Al_2O_3 indicates mineralogical maturity of sediment[12].

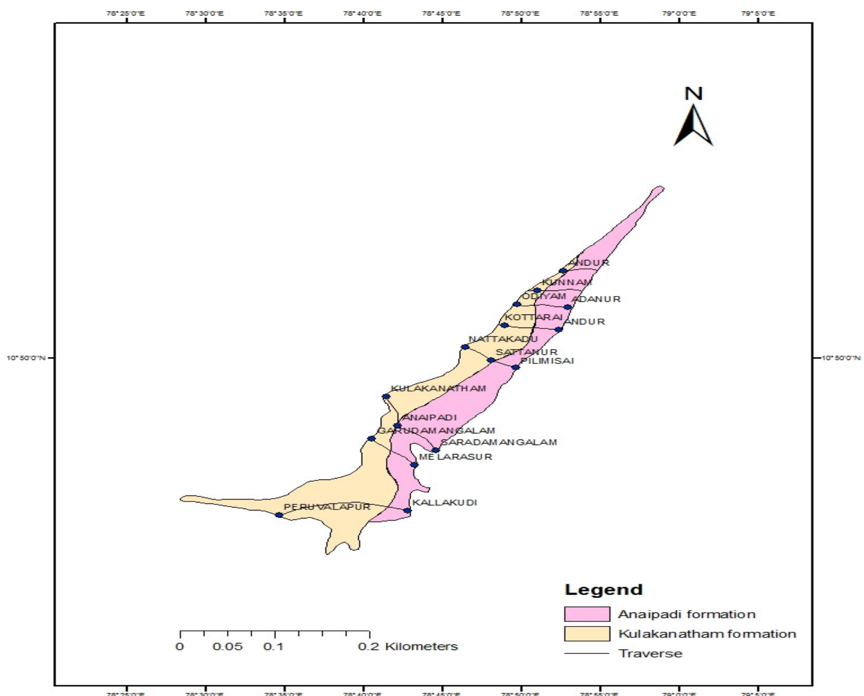

Figure-1
Study area Map

Table-1
Major Oxide composition of Garudamangalam Sandstones

Sample	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	S	Na_2O	K_2O	MnO	TiO_2	P_2O_5	LOI
SKR-53	12.93	3.49	4.20	45.90	0.86	0.05	0.60	0.44	0.40	0.20	0.05	30.67
TAY-60	24.82	8.40	5.83	33.16	1.52	0.06	1.37	1.24	0.24	0.49	0.04	22.5
PL-27	42.10	5.63	5.78	27.45	0.75	0.09	1.21	0.58	0.16	0.32	0.05	15.6
PL-25	42.56	5.09	2.29	27.61	2.44	0.03	0.95	0.51	0.08	0.29	0.04	17.89
PAM-13	18.84	5.41	22.02	23.53	1.81	0.05	0.25	1.62	0.30	0.55	0.21	25.19
KT-7	32.91	6.42	3.31	33.26	1.06	0.06	1.29	0.49	0.18	0.53	0.04	20.09
PVR-57	39.92	8.20	3.48	27.69	0.99	0.03	1.82	1.33	0.21	0.34	0.05	15.62
ANP-40	39.55	6.21	3.69	29.48	1.20	0.06	1.39	0.55	0.30	0.60	0.03	16.58
MAR'62	25.75	6.46	3.09	36.26	1.36	0.05	1.01	1.41	0.05	0.45	0.075	23.48
APM-35	28.15	8.47	3.53	34.16	1.44	0.04	2.01	0.64	0.30	0.41	0.02	20.31

It also distinguishes between quartz-rich high ratio sandstone and clay-rich low ratio shale. Fe_2O_3/K_2O is an indication of the mineralogical stability of the sediment[13]. This distinguishes the lithic fragments from feldspar in a variety of sandstones.

Table-2
Log ratios for SiO_2/Al_2O_3 and Fe_2O_3/K_2O, CaO concentrations (%) for Garudamangalam Sandstones

Sample	SiO_2	Al_2O_3	Fe_2O_3	K_2O	$logSiO_2/Al_2O_3$	$log(Fe_2O_3/K_2O)$	CaO	LOI
SKR-53	12.93	3.49	4.20	0.44	0.57	0.98	45.90	30.67
TAY-60	24.82	8.40	5.83	1.24	0.47	0.67	33.16	22.5
PL-27	42.10	5.63	5.78	0.58	0.87	1.00	27.45	15.6
PL-25	42.56	5.09	2.29	0.51	0.92	0.66	27.61	17.89
PAM-13	18.84	5.41	22.02	1.62	0.54	1.13	23.53	25.19
KT-7	32.91	6.42	3.31	0.49	0.71	0.83	33.26	20.09
PVR-57	39.92	8.20	3.48	1.33	0.69	0.42	27.69	15.62
ANP-40	39.55	6.21	3.69	0.55	0.80	0.83	29.48	16.58
MAR'62	25.75	6.46	3.09	1.41	0.60	0.34	36.26	23.48
APM-35	28.15	8.47	3.53	0.64	0.52	0.74	34.16	20.31

Table-3
Pair of paints defining the sand class field boundary line[13]

Field boundary	Log SiO_2/Al_2O_3	Log Fe_2O_3/K_2O
Quartz arenite order	1.6 1.8	-1.0 1.5
Fe-sand: Fe shale	0.71 0.71	0.6
Ferrugioneous Non ferrugenious	1.72 0.0	0.6 0.6
Shale: Greywacke	0.55 0.71	-0.1 1.5
Greywacke: Litharenite/arkose	0.643 0-89	-0.5 0.6
Feldspathic: lithic	0.7605 1.68	0.05 0.05
Subarkose/sublitharenite Litharenite/arkose	1.0 1.1375	-1.0 0.6

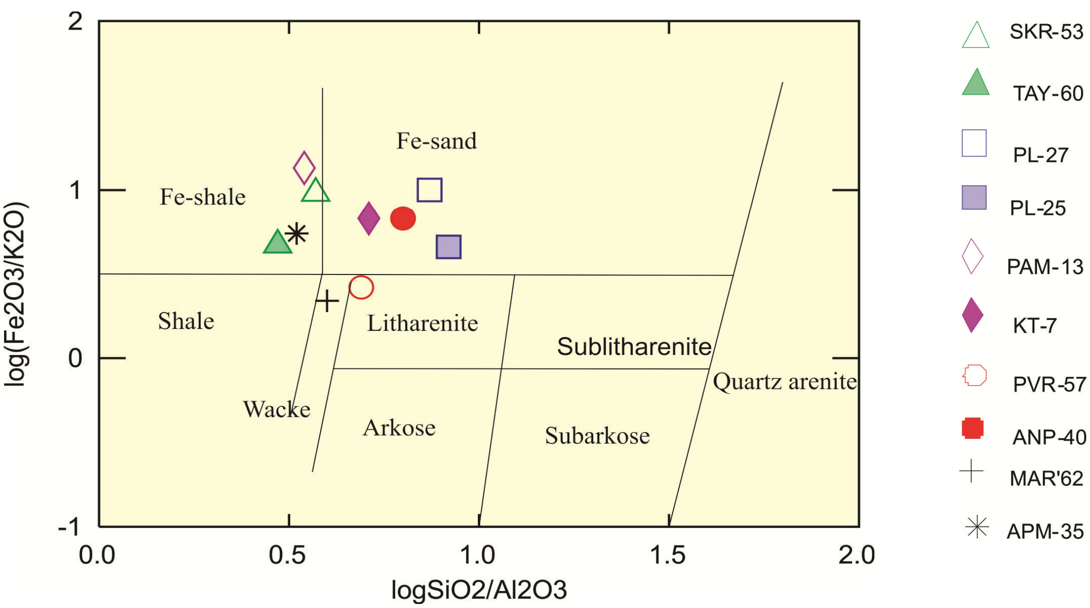

Figure-2
Log SiO_2/Al_2O_3Vs log Fe_2O_3/K_2O

Conclusion

Sandstone samples were geochemically analysed in order to classified Lithic arenites. It may be confirmed to high Cao values of samples. It indicates they are rich in calcite cement, or it may mean shell fragments in the sandstone particles. Litharenites, are sandstones with a significant (>5%) constituent of lithic fragments, however quartz and feldspar are usually present as well, along with some clayey matrix. Lithic sandstones can have a speckled (salt and pepper) or gray color, and are usually associated with one specific type of lithic fragment i.e., igneous, sedimentary, or metamorphic.

Acknowledgement

We thank India Cements, Dalvoi, Ariyalur, for facilitating XRF Analysis.

References

1. Banerji R.K., Stratigraphy and micropalaeontology of Dalmiapuram Formation (Lower Cretaceous) – A rock stratigraphic unit of South India, *Jour.Pal.Soc.India*, **(15),** 32-41 **(1972)**

2. Banerji R.K., Evolution of the Cauvery Basin during Cretaceous, Proc. Cretaceous of India, *Ind.Assoc.Palyn.,* 22-39 **(1983)**

3. Blanford H.F., On the Cretaceous and other rocks of the South Arcot and Trichinopoly districts, *Mem Geol Soc India*, **4**, 1–217 **(1862)**

4. Pettijohn F.J., Potter P.E. and Siever R., Sand and Sandstone, Berlin: Springer-Verlag Publication, 618, **(1972)**

5. Ramanathan S., Stratigraphy of Cauvery Basin with reference to its oil prospects, *Mem.Geol.Soc.India*, **2,** 153-167 **(1968)**

6. RamaRao L., Recentcontributions to our knowledge of Cretaceous rocks of South India, *Proc.Ind.Acad.Sci.,* **44**, 185-254 **(1956)**

7. Ramasamy S. and Banerji R.K., Geology, Petrography and systematic stratigraphy of Pre-Ariyalur sequence in Tiruchirapalli District, Tamilnadu, India, *Jour.Geol.Soc.India*, **(37),** 577-594 **(1991)**

8. Ramkumar M., Doris Stuben and Zsolt Berner Lithstratigrphy, depositional history and sea level changes of the Cauvery Basin, southern India, *Jour.of Annales Geoligiques de la Peninsule Balkanique,* **(65),** 1-27, **(2004)**

9. Sundaram R. and Rao P.S., Lithostratigraphic classification of Uttatur and Trichinopoly Group of rocks in Triruchirapalli District, Tamilnadu, *Geol.Surv.India, Misc.Publ.*, **(45),** 111-119 **(1979)**

10. Tewari A., The Middle to Late Cretaceous microbiostratigraphy (foraminifera) and lithstratigraphy of the Cauvery Basin, Southeast India, Published Ph.D., Thesis **(1996)**

11. Tewari A., Malcom B., Hart and Matthew P. Watkinson Teredolites from the Garudamangalam sandstone formation formation, Cauvery basin, South east India, *Ichnos: An International journal of Plant and Animal Traces,* **6(1-2),** 75-98 **(2008)**

12. Morton A.C., Influences of provenance and diagenesis on detrital garnet suites in the Palaeocene Forties Sandstone, Central North Sea, *Journal of Sediementary Petrology*, **57**, 1027-1032 **(1987)**

13. Heron M.M., Geochemical classification of terrigenous Sand and Shale from core or log data, *Journal of Sedimentary Petrology*, **(40)**, 40-53 **(1988)**