CHAPTER 11

CLASSIFICATION

Classification concepts for clastic rocks have been often been discussed by several authors. A classification is basically an attempt to group the objects of concern into class and categories to which the name can be given. With progress of sedimentological studies many separate classification of sandstones has been proposed from time to time. The main basic problem of classification should be the choice of objectively determinable characters. It seems best to select such features for classification which give more reflection into rock genesis. Therefore, descriptive classification based on observable and measureable parameters are generally adopted for the purpose. Ideally, once a rock has been classified, its position in the classification scheme should shed some light on its origin (Boggs, 1967). Moreover, the classification of sandstone also bears considerable importance in interpreting the paleogeographic and tectonic background of the provenance. Now-a-day, many authors also conclude that meaningful chemical criteria or parameters can be applied for broad studies of sedimentary rocks.

Therefore, the fundamental principles considered for the classification of sandstones are provenance factors, fluidity factors, textural maturity, mineralogical maturity, diastrophism, primary sedimentary structures, climate and weathering, post-depositional diagenesis and chemical parameters.
The modern scheme for sandstone classification was put forward by Pettijohn (1943), and followed by Krynine (1948). At present, there are numerous sandstone classification, most of them based on the works of Krynine and Pettijohn. In most cases, the fundamental classification of sandstones involves the mineralogical parameters like quartz, feldspar, rocks or lithic fragments and matrix. In 1970, Moore, et al., proposed a new scheme of classification, relating to geochemical implication of silicon-aluminium-iron ratio. Later on, a chemical concentrations to common sandstone classification, applicable for terrigenous sand and shales was presented by Herron (1988).

Following these views, classification of the present Barail sandstones has been done as follows: Textural classification, indices classification, mineralogical classification, geochemical classification, and chemical classification.

11.1 Textural (Genetic) Classification

11.11 Introduction

Sedimentary rocks are characterised by extreme variation in composition and grain size. Folk (1954), has pointed out that the classification based on the textural data of the sediments best reflect its genetic significance (Dean et al., 1985; Sarma, 1988). Folk (1954), classified the sedimentary rock basing on sand, silt and clay particles. The term sand for the purpose is used for particles, lie between 0.06 to 2 mm (or -1 Ø to 4 Ø), silt between 0.06 to 0.004 mm (or 4.1 Ø to 8.0 Ø) and clay less than 0.004 mm (or greater than 8.0 Ø)(Pettijohn, 1975).
11.12 Methods of study

The data obtained from the size analysis (Table 3), has been grouped into sand, silt and clay classes (Table 18) considering the percentage of clay as zero, in the present case. All these data were then plotted in a triangular diagram of sand, silt and clay, as suggested by Folk (1954, 1980).

11.13 Observation

On plotting the sand, silt and clay percentages of the present Barail sandstones (Fig. 32) it is observed that the most of the samples occupied in the field 'M', few in the field 'L', and three in the field 'N'.

11.14 Interpretation and conclusion

From the study of the textural classification, it was found that the sediments of the present Barail sandstones belong to "Silty sand" and "Sandy silt" group. The clay components in the sediment is zero, to effect the bulk constituents. According to Folk (1954), textural maturity concept, sediments pass sequentially through four stages of textural maturity, depending on the stability of the depositional site and input of modifying energy. He also mentioned that in mature stage, the grains are well sorted and show low value of roundness. As the present Barail sandstones are fine to very fine grained and well sorted in nature, it may be concluded that the sand and silt size materials of the sandstone belong to a mature stage. This also indicates that the sediments might have travelled a long
distance to reach the site of deposition.

11.2 Grain size indices classification

11.21 Introduction

Doeglas (1968), has proposed a classification of sandstones, based on grain size indices following Wentworth's phi value as $Q_1(75 \text{ p.c.})$, $Md (50 \text{ p.c})$ and $Q_3(25 \text{ p.c.})$, which was originally proposed by Niggli (1948). He was also of the view that this indices classification is a good tool to interpret environment of deposition.

11.22 Methods of study

For the grain size indices classification of the present sandstone, the values of $Q_1$, $Md$, and $Q_3$, obtained from the thin section mechanical analysis were plotted in the $Q_1-Md-Q_3$ diagram (Fig. 33). The value of the median ($Md$) were plotted on the diagonal line, while $Q_1(25 \text{ p.c.})$ and $Q_3(75 \text{ p.c.})$ were plotted vertically above and below respectively on the median point. The values of $Q_1$, $Md$, and $Q_3$ were also rounded off as suggested by Doeglas (1968), to find out the grain size indices, for each sample as shown in Table 19.

On completion of the plot, the nomenclature of each sandstone unit has been made on the basis of the indices as suggested by Doeglas (1968). Doeglas (1968) has not suggested any method for grouping the whole rock unit as one. For this purpose the following procedure has been tried and group nomenclature has been adopted. The value of the first quartile ($Q_1$), median ($Md$) and third quartile ($Q_3$), were
averaged separately. By rounding off the average values, a new value was obtained and it was then named accordingly.

11.23 Observation

It has been observed by plotting the indices data of the present Barail sandstone that the median (Md), lies in the diagonal of Doegla's (Fig. 2, p 85, 1968) and varies from 2.3 Ø to 4.1 Ø, Q₁ lie above the diagonal and varies from 2.2 Ø to 3.8 Ø and Q₃ lie below the diagonal and varies from 3.0 Ø to 4.5 Ø (Fig. 33). From this classification it is observed that the sizes of the present Barail sandstone ranges from "Fine sand to very coarse silt", but for the whole rock group the value of Q₁-Md-Q₃ shows that the sandstone consists of "Very fine sand".

11.24 Interpretation and conclusion

From the observation of grain size indices classification, it is evident that the present Barail sandstones consist of sediments ranging from "fine sand" to "very coarse silt". Nomenclature deduced from different samples in the classification has been given against each sample (Table 19). Moreover, overall average grain size indices in 344 which indicate that they are "very fine sand". Therefore, from this classification the Barail sandstones can be designated as "very fine sand".

11.3 Mineralogical classification

11.31 Introduction

Chen (1968), proposed a mineralogical classification in order to make the classification more reasonable and practical. His scheme is same as the sandstone classification of McBride (1963).

11.32 Methods of study

For mineralogical classification the percentages of QFR (Table 11), components were plotted in the standard QFR diagram (Fig. 34). The percentage values of QFR were calculated from the model analysis data used for petrographic study, following the three mineralogical end poles as suggested by Chen (1968).

11.33 Observation

From this mineralogical classification using "QFR" diagram it has been observed that "Q" pole has maximum percentages, followed by "R" pole and "F" pole. "Q" varies from 77.36% to 60.39%, "R" varies from 38.63% to 21.22% and "F" varies from 2.26% to 0.04% (Table 11). The percentages of QFR component of the Barail sandstones, when plotted in the Q-F-R triangular diagram (Fig. 34), shows that most of the samples concentrate on the 12 subdivision of the lithic wing IV. Only a few samples, lie in the boundary of the subdivision 5 (sublithic arenite) and 12 (litharenite) of Chen (Fig. 1, p 56, 1968).

11.34 Interpretation and conclusion

From the observation of the mineralogical classification, it
can be concluded that the sandstones of the present Barail Group belong to "litharenite group" and only a few of them inclined toward "sublithicarenite" clan with little higher percentage of silica (Fig. 34). In most sandstones silica percentages vary from 75% to 60%, rock-fragment varies from 38% to 20% and feldspar percentage below 2% (Table 11), indicate that the sandstones of the Barail Group belongs to "litharenite" subdivision of the lithic group (Chen, 1968).

11.4 Geochemical classification

11.41 Introduction

Moore, et al. (1970), proposed a geochemical classification based on Silicon-Aluminium-Iron ratio. In the present case, plot of the elemental ratios of Si-Al-Fe show a very definite relationship for clastic sediments.

11.42 Methods of study

In geochemical classification Silicon-Aluminium-Iron oxides percentages were used. The percentages of individual oxides have been calculated in respect of the amount of element used in the formula as shown below:

\[
\text{Amount of element in compound} = \frac{\text{At. wt. of the element}}{\text{Mol. wt. of the compound}} \times \text{percentage of the compound.}
\]

These data were recalculated into percentages (Table 20), to know their relationship towards clastic sediments in the classification of the sandstones.
11.43 Observation

On plotting the values of Si-Al-Fe in the triangular diagram (Moore, et al., 1970), (Fig. 35), it is observed that the samples of the present Barail sandstones scattered in the sandstone field (between 92.5% to 85.0%), and subgraywack field (between 85.0% to 77.5%). Only two samples lie in graywack field (between 77.5% to 70.0%). All the samples lie below the granitic (G) boundaries of granitic-basaltic (G-B) line as in the diagram (Fig. 1, p 1148, Moore, et al., 1970), drawn for the Si-Al-Fe ratios for igneous rocks from granites through basalts. Moreover, all the points of the present sandstones plotted in the diagram falls in the well define zone of Al/Fe ratio between 1.5-2.5, (Fig. 35).

11.44 Interpretation and conclusion

From the geochemical classification, it is seen that 50% of the sandstones occupied the "subgraywack" field, 30% occupied the "Sandstone" field and 10% occupied the "graywack" field. Other 10% lie in the boundary line between orthoquartzite and sandstone (Fig. 35). From these observation it may be concluded that the sandstones of the Barail Group belong to "Sandstone" and "Subgraywack" Clan (Moore, et al., 1970). As all points fall below the granitic-basaltic (G-B) line which indicate that they are derived from granitic rock containing little aluminium and vary little iron (Moore et al., 1970).
11.5 Chemical classification

11.51 Introduction

A new scheme for relating the concentration of chemical elements to common sandstone classification applicable for terrigeneous sand and shale was represented by Herron, (1988). The scheme used for this classification was $\text{SiO}_2/\text{Al}_2\text{O}_3$ and $\text{Fe}_2\text{O}_3/\text{K}_2\text{O}$ ratio and calcium concentration available either from laboratory measurement or from geological logging tools data.

11.52 Methods of study

For chemical classification of Herron (1988), the log ($\text{SiO}_2/\text{Al}_2\text{O}_3$) and log ($\text{Fe}_2\text{O}_3/\text{K}_2\text{O}$) ratio were used. The value of the individual oxides already used in geochemical studies in this text, were recalculated into log ($\text{SiO}_2/\text{Al}_2\text{O}_3$) and log ($\text{Fe}_2\text{O}_3/\text{K}_2\text{O}$)(Table 21) and used for the present study.

11.53 Observation

By plotting the value of log ($\text{SiO}_2/\text{Al}_2\text{O}_3$) and log ($\text{Fe}_2\text{O}_3/\text{K}_2\text{O}$),(Fig. 36) (Table 20), it is seen that 2 points fall in graywack field, 8 points fall in litharenite field, 5 points fall in sub-litharenite and 4 points fall in Fe-sand field. Only 1 points fall in the arkose field. Neither of the points fall in the quartzarenite nor shale field.

11.54 Interpretation and conclusion

From the chemical classification of Herron (1988), it is seen
that most of the samples of the present Barail sandstones scattered in "litharenite" and "sublitharenite" field. Only a few of them lie in "Fe-sand" field, while 2 samples lie in the "graywack" field. From the above observation it can be concluded that the sandstones of the Barail Group are "litharenite to sublitharenite" containing little iron in them.

The overall classification of the present Barail sandstones by different methods such as textural, grain size indices, mineralogical, geo-chemical and chemical classification indicate that the sandstones are "fine to very fine" grained in nature, "litharenite to sublithicarenite" in composition and derived from granitic source of igneous or low rank metamorphic terrain. Finally, it may be concluded that the sandstones of the Barail Group of the present area are fine grained, litharenite, derived from igneous or metamorphic pre-existing rocks.