CHAPTER 8

PALEOCLIMATE

8.1 Introduction

Krynine (1935), probably first advocated the potentiality of climate in controlling sandstone composition. Later many workers like Basu (1976), Young (1976) and Potter (1978), carried out studies on sandstone composition in relation to climate conditions. Suttner et al. (1981), note that the role of depositional environment also need consideration and suggested that climatic influence is the strongest in first cycle fluid sands near the source, and is probably less in the material of first cycle marine sands. Therefore, systematic variation in compositional maturity of sandstones reflects the changing climate during deposition. Hence, climate is considered to be a critical factor affecting maturity (Suttner and Dutta (1986).

Climate affects sands composition through its influence on pedogenic process, which brings about parent rock destruction. These processes convert a small population of large rock-fragments into detritus made up of several populations, rock-fragments and monomineralic grains to polycrystalline quartz. Young (1976) and Basu (1976), have demonstrated that the ratio of the feldspar plus lithic rock-fragments to polycrystalline quartz or to total quartz are sensitive indicators of the climatic heritage of sands. This climatic signature will be preserved in the sands when they are deposited, if sands do not suffer sedimentary differentiation via long distance transport and deposition in high energy environment (Suttner et al.,
Results of the study shows that the optimum conditions for the production of distinctive climatic signature on sandstone composition are met in extentional plate tectonic setting. This setting can be visualised from the triangular plot of quartz, feldspar and rock fragment data as per Dickinson and Suczek (1979). Plotting of compositional data on QFR diagram facilitates rapid visualitional of provenance climate (Suttner and Dutta, 1986), achieved striking results by this ternary plot in comparison of Gondwana rocks of India as well as in U.S.A.

The framework composition of sandstones are the most sensitive to climatic control. A bivariate log/log plot based on polycrystalline quartz to feldspar plus rock-fragments and total quartz to feldspar plus rock-fragments ratio permits sharp discrimination (Suttner and Dutta, 1986, p 338).

Chemical maturity can be expressed in terms of $SiO_2$ content and/or chemical maturity index $SiO_2/Al_2O_3$ (Potter, 1978). A bivariate plot of $SiO_2$ against $Al_2O_3 + K_2O + Na_2O$, best represents the chemical maturity trends as a function of climate.

8.2 Methods of study

The framework composition of the sandstones required for this purpose has already been calculated for petrographical studies, following Gazzi-Dickinson point counting method 1984, in Ingorsoll and Suczek (1979). The results were computed (Table 13) and plotted to construct the ternary diagram of QFR (Suttner and Dutta 1986).
Same data are also used for the construction of the bivariate log/log plot of polycrystalline quartz to feldspar plus rock-fragment and total quartz to feldspar plus rock-fragment ratio (Suttner and Dutta, 1986)(Table 14).

The data of the chemical analysis already dense for geochemical analysis (Chapter 13, Table 22 of this text) of 20 samples are used in order to determine their maturity and climate. A bivariate plot of $\text{SiO}_2$ percentage and total percentage of $\text{Al}_2\text{O}_3 + \text{K}_2\text{O} + \text{Na}_2\text{O}$ was constructed from the chemical analysis data (Table 15).

8.3 Observation

Plotting of framework compositional data on QFR diagram, shows that all the samples of the present Barail sandstones occupied the sub-humid, recycled orogen provenance (Fig. 22) environmental field of Suttner and Dutta (1986).

The plotting of framework compositional data in the bivariate log/lg plot of polycrystalline quartz to feldspar + rockfragments versus total quartz to feldspar + rockfragments, shows that most of the points occupied the semi-humid field of Suttner and Dutta (1986), (Fig. 23).

The bivariate plot of $\text{SiO}_2$ versus $\text{Al}_2\text{O}_3 + \text{K}_2\text{O} + \text{Na}_2\text{O}$ shows that 65 percent of the samples occupied the humid environmental field, while 35 percent scattered in arid environmental field of Suttner and Dutta (1986), (Fig. 24).
8.4 Interpretation and conclusion

According to Suttner and Dutta (1986), the framework composition of the present sandstones in the study of bivariate log/log plot based on polycrystalline quartz to feldspar + rockfragments versus total quartz to feldspar + rockfragments ratio permit sharp discrimination on paleoclimatic interpretation. From the bivariate log/log plot of the framework composition of the Barail sandstones, the paleoclimate of the depositional area has been inferred to be as semi-humid. The QFR ternary diagram also indicates that the sediments of the Barail sandstone were deposited in sub-humid climate.

The chemical maturity is represented by quartz content of the unit (Potter, 1978). The maturity of the Barail sandstones also supported by quartz content of the unit, (68.3 to 90.4% quartz) sandstones derived from low to intermediate relief source area under humid climatic conditions and/or deposited in shallow marine environments under conditions of slow sedimentation may be depleted in liable grains and enrich in detrital quartz (Mack, 1984). The average percentages of QFR in the present Barail sandstones are 68:1:31, indicate that the sediments of the present Barail sandstones were derived under humid to sub-humid climatic conditions having intermediate relief.

The bivariate plot of SiO₂ against Al₂O₃ + K₂O + Na₂O (Fig. 24), neither represent high maturity index nor low maturity index, most of them show moderate maturity index, which indicate that the
sediments of the Barail sandstones of the present area were derived and deposited in moderately weathering environment of humid climate.

From the above all studies, it may finally be concluded that the present Barail sandstones were deposited under semi-humid to humid climatic conditions.