CHAPTER - 10
PALEOCLIMATE
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Climate has a definite influence over the variation in compositional maturity of the sandstone. Climate is considered to be the critical factor affecting maturity (Suttner and Dutta, 1986). Whereas, Dott (1978) opined that climate is not a factor to be considered in understanding sandstone genesis. Darnell 1974; Young et al., 1975; Potter 1978; Suttner et al., 1981; Franzinelli and Potter 1983 (in Suttner and Dutta, 1986), studied Holocene sand composition in contrasting climates and provided some basis for interpreting the role played by climate in compositional maturation of sand. Results of the Holocene studies now assist to infer paleoclimate from ancient sandstones.

Climate affects sand composition through its influence on pedogenic processes which converts a small population of large rock fragments into detritus made up of several populations of smaller rock fragments and monominerallc grains, including polycrystalline quartz. Young et al. (1975), have shown that if the same parent rock is weathered in contrasting wet and dry climates, under comparable conditions of relief, the detritus produced will have a framework composition unique to the climate in which it is produced. They have shown that ratios of feldspar plus lithic fragments to polycrystalline quartz or to total quartz are sensitive indicators of the climatic heritage of sand.

Results on the study, support that the optimum conditions for the production and preservation of a distinctive climatic signature on sand composition are met in extentional plate tectonic setting. This setting can be best understood from the triangular plot of
quartz, feldspar and rock fragments data as per Dickinson and Suczek (1979).

Burial diagenesis converts sand to sandstone and can destroy framework grains in various proportions. Only with exceptionally deep burial diagenesis is the climatic control on framework composition of nonmarine sediments altered beyond recognition because of pervasive dissolution of silicate minerals and rock fragments (Suttner and Dutta, 1986). Plotting of framework compositional data on Q.F.R. diagram facilitates rapid visualization of provenance climate (Suttner and Dutta, 1968). A bivariant log/log plot based on QP/F+R and Qm*QP/F+R ratios permits sharp discrimination to the climatic control over the sandstone framework composition. Suttner and Dutta, 1986, achieved striking results by these plots in comparison of Gondwana rocks of India and U.S.A.

Chemical maturity can be expressed in terms of SiO2 content and/or chemical maturity index (CMI), SiO2 /Al2O3 (Plotter, 1978). Bulk chemical composition data support interpretation of climate from framework mineralogy. A bivariant plot of SiO2 percentage against total Al2O3 +K2O + Na2O percentages, best represents the chemical maturity trend as a function of climate.

METHODS OF STUDY:

The framework composition of the Surma and the Tipam groups of sandstones have been calculated for petrological studies. These results were computed and plotted to construct the bivariant log/log plots of the ratios of polycrystalline quartz (QP), to feldspar plus rock fragments (F+R), against the ratios of total quartz (Q=Qm (monocrystalline quartz) +Qp) to feldspar plus rock fragments (F+R). Paleoclimatic fields are indicated by arrows for separate climatic fields (Suttner and Dutta, 1986).
Ternary plots of framework composition were also made for the Surma and the Tipam sandstones. The provenance field boundaries were plotted from Dickinson and Suczek (1979), and climatic fields were traced from Suttner and Dutta (1986).

Standard wet chemical analysis were made of the Surma and the Tipam sandstones, in order to determine their chemical maturity and climate. A bivariate plot of SiO percentage and total percentages of $\text{Al}_2\text{O}_3$, $\text{K}_2\text{O}$, and $\text{Na}_2\text{O}$, was constructed for the Surma and the Tipam sandstones. The chemical maturity of the sediments and the paleoclimate were studied from the bivariate plots diagram, following Suttner and Dutta (1986).

**Observation:**

The average Q.F.R. content of the Surma and the Tipam sandstones is 77:3:20 and 77:4:20 respectively. The average value of the $Q_m+Q_p/F+R$ and $Q_p/F+R$ ratios for the Surma sandstones is 3.2 and 0.41, respectively. While the average value of the $Q_m+Q_p/F+R$ and $Q_p/F+R$ ratios for the Tipam sandstones is 3.4 and 0.31, respectively (Table 41 and 42).

Plotting of framework compositional data in the log/log bivariant plot of polycrystalline quartz/Feldspar plus rock fragments to total quartz/feldspar plus rock fragments, show that the points plots in the environmental field allotted for semihumid climate (Fig. 10:1 and 10:2) for both of the Surma and the Tipam groups of sandstones.

Plotting of framework compositional data of Q.F.R. diagram show that points representing of the Surma and the Tipam sandstones clusters around sub-humid environmental field (Fig 10:3).

The bivariate plots of SiO against total $\text{Al}_2\text{O}_3$, $\text{K}_2\text{O}$, and $\text{Na}_2\text{O}$ shows semi-arid environment of the Surma sandstones while in case of Tipam sandstones shows semi-humid climate (Fig 10:4).
INTERPRETATION AND CONCLUSIONS:

From the bivariate log/log plots of framework composition of the Surma and the Tipam sandstones, the paleoclimate has been inferred to be as semi-humid. The QFR triangular plots also indicates semi-humid climate during the time of deposition of both the sandstone groups. Sandstones of the Surma and the Tipam groups are sub-mature. This is evident from the moderate values of the ratios between total quartz to feldspar plus rock fragments and polycrystalline quartz to feldspar plus rock fragments. Relatively greater content of rock fragments in the Surma and the Tipam sandstones indicates perhaps a combination of shorter transport and steeper slope gradients of the depositional sites under the influence of sub-humid to humid tropical climatic conditions (Suttner and Dutta, 1986).

The moderate mean SiO₂ and SiO₂/Al₂O₃ contents of the sandstones of the Surma and the Tipam groups suggest sub-mature sandstones such as lithic arenites, graywackes and arkose (Blatt et al., 1972; Potter, 1978).

Therefore, from the above observation and interpretation it may be concluded that both the sandstones of the Surma and the Tipam are the product of tropical or subtropical type of climate which is a combination of high temperature and high humidity in areas of low relief. Sediments of the sandstones come from near by source areas and transported along the steeper slope gradients and produced sub-mature to immature sandstones.
EXPLANATION OF THE FIGURES ::

Quartz Total
Feldspar + Rock Fragments
Fig. : 10:2.

Quartz Total
Feldspar + Rock Fragments
Fig. : 10:1
EXPLANATION OF THE FIGURE ::

FIG: 10:3  PALAEOCLIMATE DISCRIMINATION PLOTS OF Q.F.R.
DIAGRAM OF THE SURMA AND TIPAM GROUPS OF
SANDSTONES ( AFTER SUTTNER AND DUTTA, 1986;
PROVENANCE FIELD BOUNDARIES ARE TAKEN FROM
DICKINSON AND SUCZEK, 1979).
Fig 10:3 QRF Content Triangular plot for the Surma and the Tipam Sandstones for evaluation of Paleoclimate (after Suttner and Dutta, 1986).
Provenance field boundaries are taken from Dickinson and Suczek, 1979.
Fig 10.4 Chemical maturity of the Surma and the Tipam sandstones expressed as a function of percent SiO₂ and total percent of Al₂O₃, K₂O and Na₂O. (After Suttner & Dutta, 1986).

i) Surma sample — •
ii) Tipam sample — △