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# PETROGRAPHY OF SANDSTONES OF SIRKANG AREA (PARBAT DISTRICT) CENTRAL WEST NEPAL HIMALAYA

B. N. UPRETI

*Department of Geology, Tribhuvan University, Kathmandu, Nepal.*

## सारांश

प्रस्तुत लेखमा कालीगण्डकी उपत्यकाको परिवर्तित पत्रे चट्टान–बालुवा ढुङ्गा (Sandstone) को पेट्रोग्राफिक अध्ययनको आधारमा यी ढुङ्गाहरूलाई पांच मुख्य प्रकारमा विभाजन गरिएको छ। यी ढुङ्गाहरूको मौलिक पत्रिय बुनौट तथा संरचना (Texture and structure) राम्ररी सुरक्षित रहेको, कायान्तरण प्रकृयाको प्रभाव कम रहेको पाईयो।

## ABSTRACT

Different varieties of sandstones are identified from the Lesser Himalayan low grade metasediments of Kali Gandaki Valley. In previous literatures they were very loosely described as quartzites, metasandstones and sandstones. On the basis of a detailed petrographic study, the author has classified these sandstones into five main types, viz. quartz arenite, sublitharenite, feldspathic graywacke, lithic graywacke and dolomitic sandstone; and their paleoenvironmental significance has been discussed. The primary sedimentary textures and structures are strikingly well preserved and the regional metamorphism has caused only mild changes in these rocks.

## INTRODUCTION

The rocks of Sirkang area along Kali Gandaki Valley, belong to the Nawakot Nappe no. 3 of Hagen (1969); Tansing Unit (Nagthat and Chanpdpur) of Fuchs & Frank (1970), Dhorpatan Phyllite Zone (Upper Calc-argillaceous subgroup of Midland Metasediments) of Ohta & Akiba (1973); Purple Foımation (Suparitar Series) of Nadgir & Nanda (1966) and possibly Nawakot Complex rocks of Stocklin & Bhattarai (1977).

Recently, a detailed stratigraphy and structures of this area has been worked out by Upreti (1979) and Upreti et al. (1978, 1980 a, b). The sandstones described in this paper belong to the Sumsa Formation of Sirkang Unit (Fig. 1).

The sandstones of Sirkang Unit are interbedded with argillaceous rocks like slates and slaty phyllites; these are confined to the Sumsa Formation which lies above the Phoksing Dolomite. The thickness of the individual bands of sandstones is quite variable ranging from a few centimeters to a few meters and sometimes over 100 m. The thinner bands of sandstones are finely intercalated with slates and salty phyllites. The dolomitic sandstones are mostly found intercalated with purple slates and they occasionally are found in the form of lenses.

Following the classification of Pettijohn et al. (1973), the modal analyses shows the five main varieties of sandstones (Fig. 2 & 3), viz. quartz arentite, sublitharinite, feldspathic graywacke, lithic graywacke and dolomitic sandstone. The equivalent names of these varieties according to the calssification of Folk et al. (1970) are shown in figure 4.

## PETROGRAPHY AND DEPOSITIONAL ENVIRONMENT

### Quartz Arenite

It is almost exclusively made of detrital quartz. Earlier, some workers called such rocks as orthoquartzites to distinguish it from the metamorphic quartzites. Krynine (1945) applied this term to sands made entirely of quartz grains cemented by silica. This term has been replaced by the term quartz arenite suggested by Williams et al. (1954) or quartzarenite by McBride (1963).

Quartz arenite as such is not abundant in the study area and it is found to occur at few places only (Purtighat area, on the left bank of Kali Gandaki river). The rock is coarse to medium grained and is associated with red shale.

Under microscope, the rock shows a well sorted nature with negligible amount of matrix. The grains of quartz are subangular to subrounded (Fig 5a). Strikingly, majority of the quartz grains show undulose extinction. The individual grains are both monocrystalline as well as polycrystalline. Around the periphery of some grains of detrital quartz, authigenic development of silica in crystallographic and optical continuity is also observed. Most of such grains, where the enlargement process is due to the authigenic overgrowth of quartz, invariably meet along irregular boundaries and result in the formation of interlocking quartz mosaic.

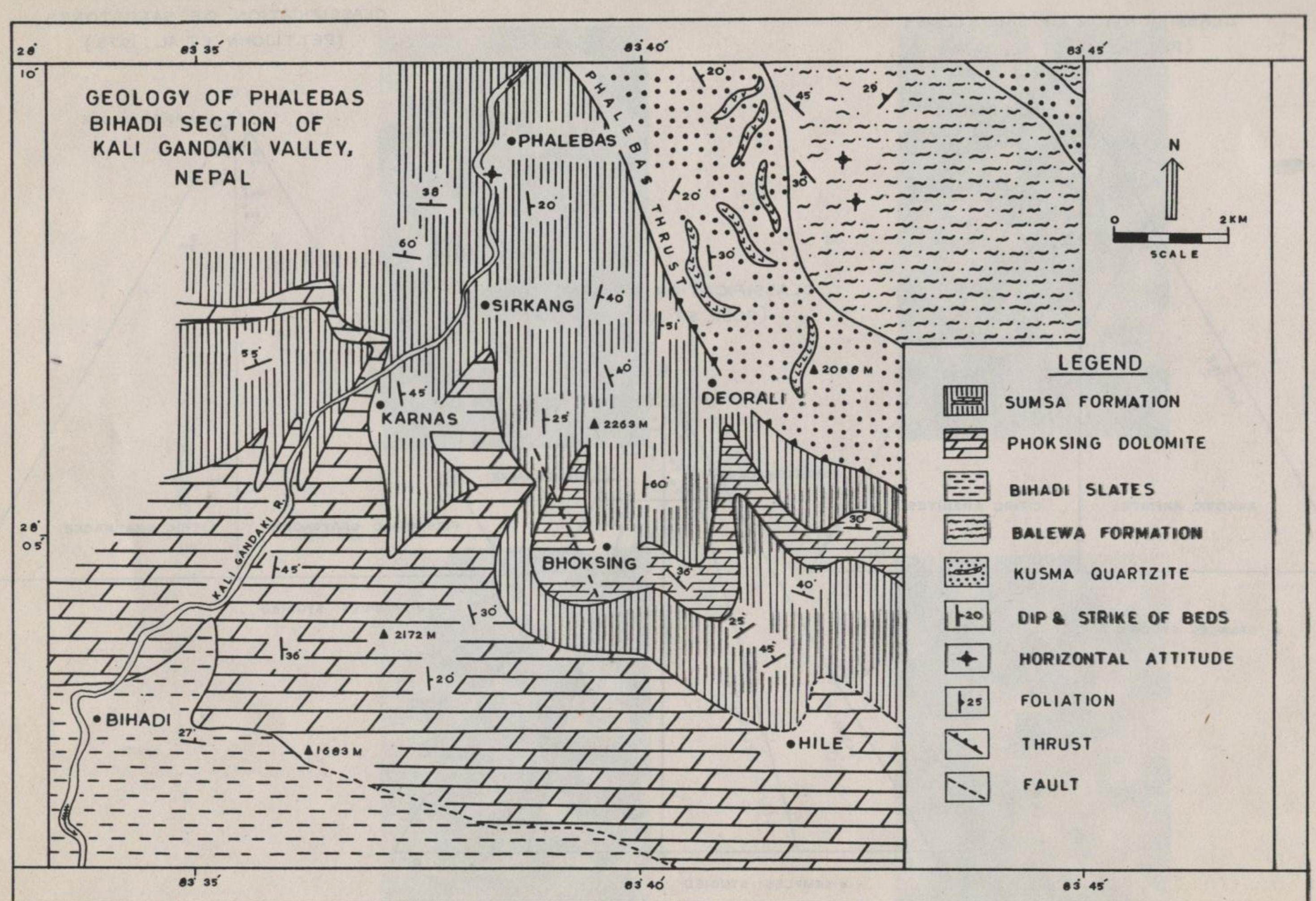



Figure 1: Geological map of Phalebas - Bihadi, Kali Gandaki valley, Nepal.

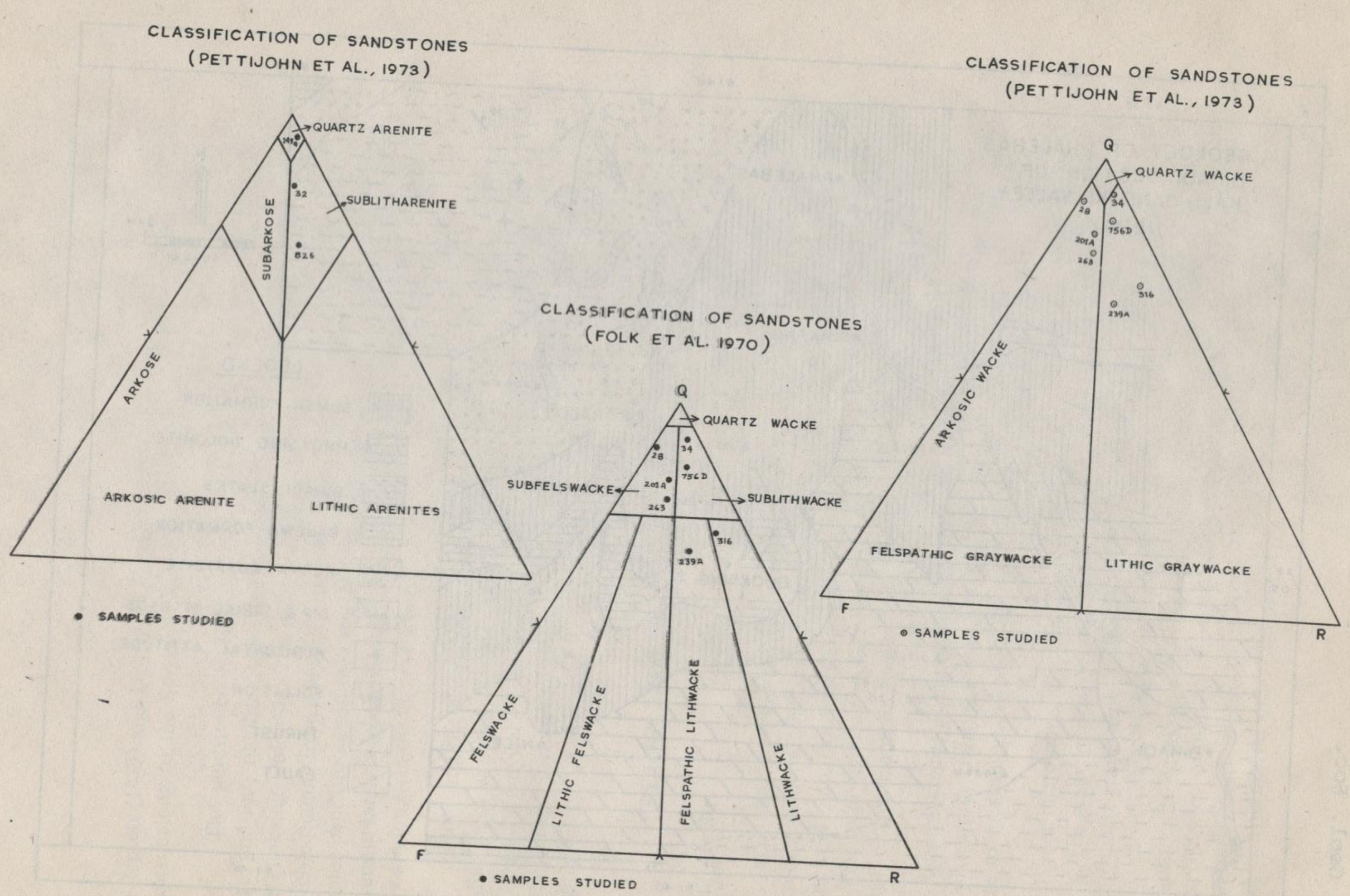



Figure 2,3,4: Classification of sandstones (Pettijohn et al., 1973 and Folk et al., 1970).

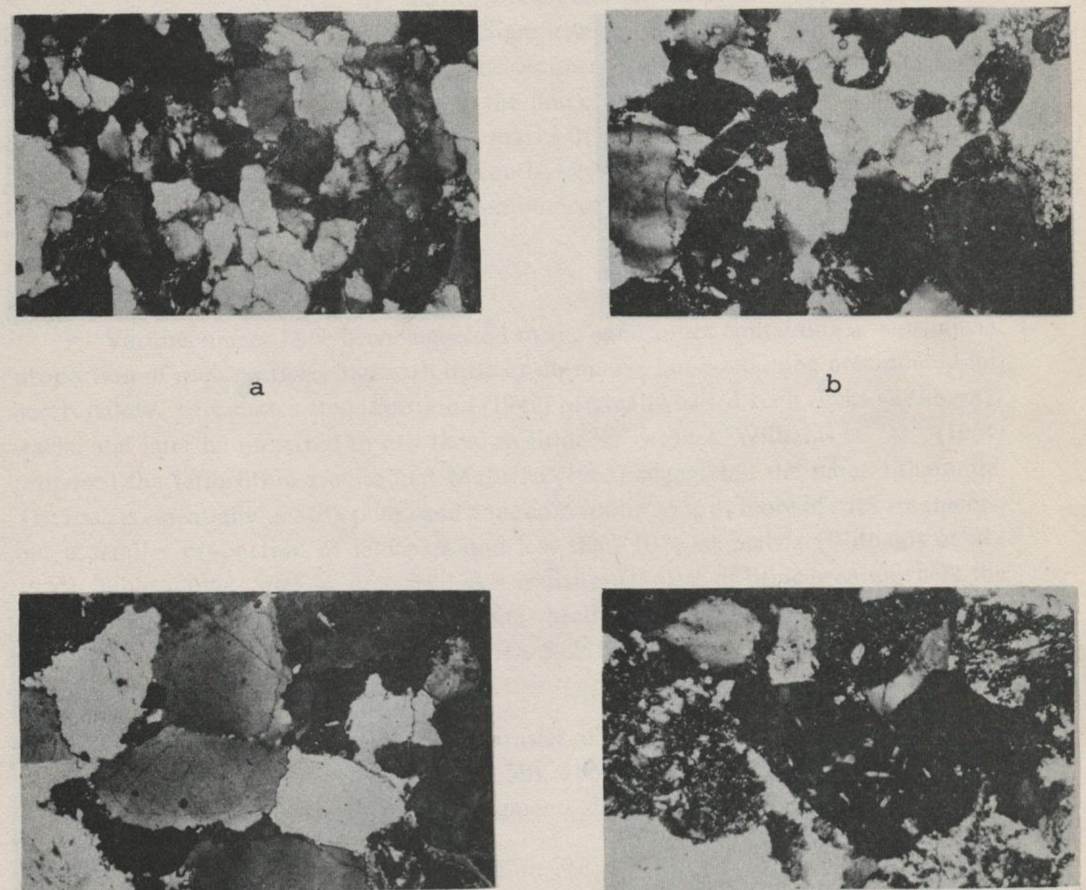
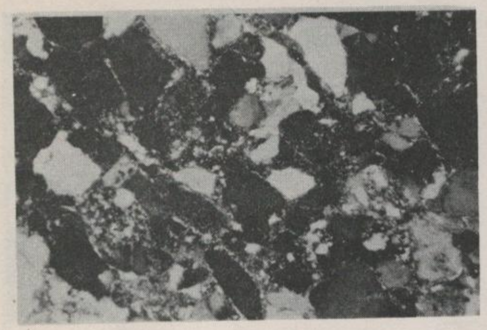
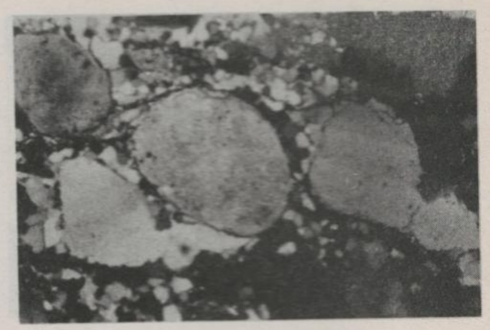



Figure 5



a



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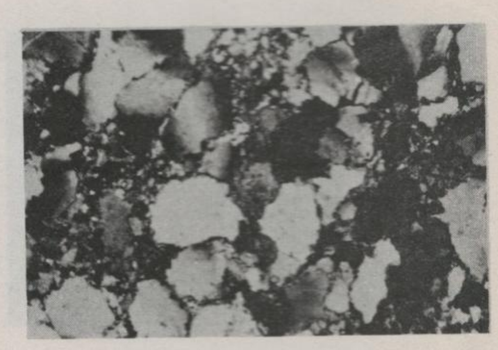

d

Figure 6

The quartz arenites contain approximately 93–94% quartz (table 1). Intergranular space is sometimes filled by argillaceous material which has been converted into fine sericite showing streaky alignment. Significantly, no feldspar grains are present, and this fact points to a mature nature of the sediments. These rocks appear to have been deposited in shallow marine shelf, where the fine clay matrix was removed easily. This is also supported by the presence of ripple marks in them. The sands were possibly derived from the Indian Shield lying to the south. On the basis of the reconstructions of paleocurrents, Valdiya (1970) came to a similar conclusion in the Kumaon Himalaya.

**Sublitharenite**

Various names have been suggested to the sandstones containing a substancial proportion of rock particles and with little or no matrix but containing precipitated minerals (silica, carbonates etc.). Pettijohn (1949) originally called such rocks as subgraywacke and later he preferred to call them as lithic sandstones. Williams et al. (1954) proposed the term lithic arenite and McBride (1963) sugggested the name litharenite. The rock is essentially matrix poor sandstone containing 25% or more of rock fragments, but a smaller proportion of feldspars and less than 10% of matrix (Williams et al., 1954). Sublitharenite may be descibed as a transitional class of lithic arenite where the rock particles are less than those in litharenite. McBride (1963) gives the modal composition of the sublitharenites as 65–90% quartz, 5–25% rock fragments and 0–10% felspars.

Sublitharenites of the study area consist of rounded to well rounded grains of quartz, rock fragments and feldspars (Fig. 5b). The rock constitutes 65–76% of quartz and 8–10% of matrix where the rock fragments dominate over the feldspars.

*Quartz* : The framework grains of quartz (both monocrystalline and polycrystalline) have long contact, point contact and concavoconvex contact with each other and are cemented by secondary quartz overgrowth. The continuous overgrowth of secondary quartz around the detrital grains has resulted in the formation of interlocking quartz mosaic (Fig 5c).

*Chert* : These rounded to subrounded chert grains show a finely speckled, twinkling appearance. Few grains of chalcedony are also observed which are cryptocrystalline, fibrous or flamboyant silica with index of refraction lower than that of quartz. Sometimes black chert and jaspers are also observed.

*Feldspars* : Around the detrital feldspar grains occasional authigenic development of feldspars (orthoclase) is observed. But the development is not in optical conti-

Table 1 Modal analyses of sandstones and their QFR values.

| Sample No. | Quartz | Feldspars | Rock fragments | Matrix & cement | Rock name |
|---|---|---|---|---|---|
| 28 | 42.91 | 4.29 | 0.48 | 52.32 | Feldspathic graywacke |
| 32 | 75.48 | 6.29 | 8.09 | 10.14 | Sublitharenite |
| 34 | 58.35 | 1.27 | 3.81 | 36.57 | Lithic graywacke |
| 149G | 93.10 | 0.98 | 3.92 | 2.00 | Quartz arenite |
| 201A | 51.35 | 6.19 | 4.33 | 38.13 | Feldspathic graywacke |
| 239A | 30.42 | 5.82 | 8.50 | 55.26 | Lithic graywacke |
| 263 | 36.72 | 5.58 | 4.18 | 53.52 | Feldspathic graywacke |
| 316 | 25.20 | 2.10 | 7.70 | 65.00 | Lithic graywacke |
| 756D | 47.38 | 2.76 | 4.96 | 44.90 | Lithic graywacke |
| 826 | 64.88 | 10.97 | 15.54 | 8.61 | Sublitharenite |

**QFR Values**

| Sample No. | 28 | 32 | 34 | 149G | 201A | 239A | 263 | 316 | 756D | 826 |
|---|---|---|---|---|---|---|---|---|---|---|
| Q | 90 | 84 | 92 | 95 | 83 | 68 | 79 | 72 | 86 | 71 |
| F | 9 | 7 | 2 | 1 | 10 | 13 | 12 | 6 | 5 | 12 |
| R | 1 | 9 | 6 | 4 | 7 | 19 | 9 | 22 | 9 | 17 |

Q – Quartz

F – Feldspars

R – Rock fragments

nuity. Among the feldspars, orthoclase is most abundant, however, microcline and plagioclase are also not rare.

*Rock fragments* : Slaty and phyllitic rock fragments are very common. They usually show an elongate outline and fine development of sericite with preferred orientation. They are mostly deformed and therefore, are spread in the form of pseudomatrix. Some devitrified glass and a few basic rock fragments (spilites ?) are also present (Fig 5b). They were possibly derived from the spilitic lava flows of the Kusma Unit. These are also sometimes squashed, deformed and altered.

Sublitharenites represent immature sands, requiring conditions favourable for the deposition of the relatively unstable minerals. Due to relatively weak character of most shales, slates, phyllites and basic rocks, they are doubtful to survive prolong action of transport. Therefore, they may be indicators of relatively local provenance perhaps even within uplifted parts of the same sedimentary basin (Pettijohn et al., 1973).

**Wacke (Graywacke)**

On the basis of framework-grains of quartz, feldspars, rock fragments and the matrix, Pettijohn et al. (1973) have classified sandstones into two main groups, viz. 'clean sands' or arenites (sands with less than 15% matrix) and the 'dirty' sands or wackes (those with more than 15% matrix). The wackes are further subdivided as lithic graywacke, feldspathic graywacke, arkosic wacke and quartz wacke (fig. 3). The wackes of the study area have been found to be lithic graywacke (Fig 6a) and feldspathic graywacke (Fig 6b).

The sand fraction in these wackes is rich in quartz, and constitutes 25–58% while the proportion of matrix varies from 36 to 65%. It is likely that the high percentage of matrix might be due to the squashed rock particles. The size and shape of the detrital grains also range within a wide limit. These highly unsorted rocks sometimes look like microbreccias due to the presence of very sharp, angular quartz and feldspar grains embedded in the matrix of fine quartz, chlorite and sericite. Frequently it is very difficult to distinguish between the deformed and squashed rock particles of pelites and metapelites from the sericitic matrix. However, the alignment of the folia of sericite and chlorite and faint relict grain boundary usually help to distinguish the two.

*Quartz* ; Due to high matrix content, the percentage of grain to grain contact is very poor and therefore, floating grains of quartz and feldspars are most common. Deformation has caused the micaceous minerals and sometimes quartz grains to show preferred orientation. Sericite is found to replace the detrital quartz grains and the original grain boundaries are mostly obliterated (Fig 6c). Here the sericite and sometimes chlorite crystals project into the clear quartz grans.

*Feldspars* ; The clastic grains of feldspars are important constitutuent of the graywacke. The proportion of the feldspars to rock fragments increases from the lithic to the feldspathic graywacke.

*Rock fragments*: The rock fragments are the essential constitutents of these wackes and comprise basically slates, phyllites and basic igneous rocks. The basic rock fragments are highly altered. Slates and phyllites are among the most common rock fragments of these wackes. Though most of the slates and phyllitic rock fragments are deformed and squashed, rendering them difficult to distinguish from the matrix, the foliations, and the distinct grain outline indicate their clastic origin. Appreciable amount of chert fragments, tourmaline and zircon are observed.

The petrographic study of the wackes of Sirkang Unit is important from the view point of the reconstruction of environment of deposition. The widespread occurrence of mud-cracks and ripple marks on these rocks indicate their deposition in shallow water condition. The wide variations in the thickness of the purple slates, dolomitic sandstones, siliceous dolomites and graywackes and their intimate association and alternations indicate a changing depositional environment, influenced by tectonics, geochemistry and provenance. The presence of weathering-prone rock fragments like basic igneous rocks, is indicative of proximity of provenance. They indicate that these rocks were deposited in a shallow water environment and the constituent materials may have been derived from a proximal site.

*Dolomitic sandstone*

Dolomitic sandstone is also frequently intercalated in Sumsa Formation. The clastic grains of quartz and feldspars are embedded in an aggregate of crystalline dolomite and fine grained quartz (Fig. 6b). Quartz grains are angular to subangular and exhibit highly undulose extinction. Feldspars (predominantly potash feldspars) show better roundness than quartz, and are invariably altered. Leaching out of carbonate cementing material renders them highly friable.

The dolomitic sandstone, in contrast to the other sandstone varieties (wackes, arenites etc), contains dolomite as cementing material, and indicate a different environment of deposition. The whole sequence of Sumsa Formation where the purple slate-siliceous dolomite-sandstones show intercalations and frequent repetition, indicate an intricate balance mainly controlled by the provenance, PH conditions of sea water and energy level.

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