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EVIDENCE OF ACTIVE FAULTING IN CHILAS DISTRICT, NORTHERN PAKISTAN

During two visits to the northern areas of Pakistan in November 1981 and October 1982, we observed evidence of active faulting in the Chilas district, Pakistan. The trace of the fault with related neotectonic features has been marked on the accompanying map (Fig. 1). A brief account of the field observations follows.

About 10km northeast from the town of Jalipur, a zone of breccia, 5-10km thick, is located along the Karakoram Highway. The breccia is found in Holocene fan-gravels developed at the foot of the Nanga Parbat massif. It is present at several locations along the road up to Rakhiot bridge, and also north of the confluence of the Indus and Astor River. Slickensides are developed in this breccia zone. Most of these appear to plunge along the dip of fault surfaces on which they are found.

Locally a fault scarp is developed in these fan gravels in association with the breccia zone. It appears to reflect a steeply dipping fault, down-thrown to the north. It is not clear from our limited data whether reverse or normal motion is present, because the dip of the bedrock fault has not yet been observed.

The trace of the fault is delineated by a line of hot springs, some right on the road and some on the river side. The ones located along the road can be easily spotted by the rising steam. The hot springs south of Rakhiot bridge are closely spaced and have a definite linear arrangement.

About 5km north of Rakhiot bridge, there is an outcrop in which bedrock is thrust over Holocene gravels. The dip of the fault is to the southeast suggesting reverse faulting. This fault segment is on line with the other features and has an associated hot spring. However, we have only been able to observe it by binoculars from across the river to date.

This portion of the Indus Valley also contains the Jalipur sandstone (Misch, 1936; Olson, 1982). This is a young sandstone unit, probably deposited in an ancestral Indus Valley of much lower relief during the Pleistocene. It is folded, locally becoming overturned on south limbs. Fan-gravels and high terraces have been widely developed above the Jalipur sandstone which is only locally preserved. The young fault scarp and associated features discussed here cut these fan- and terrace-gravels and thus are indeed very recent. This fault is probably the surface expression of the rapid uplift of the Nanga Parbat massif reported by Zeitler *et al.* (1982) on the basis of fission-track evidence.

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POSSIBLE APPLICATION OF DEDOLOMITIZATION IN STRATIGRAPHY

INTRODUCTION

In monotonous carbonate sequences, the identification of hiatuses is not always possible and thus makes detailed stratigraphic work difficult. Some workers (e.g. Goldberg, 1967; Frank, 1981) have proposed that presence of dedolomitization textures may help in identifying the unconformities in subsurface rocks. It is believed that such a possibility exists, both in outcrop and subsurface sequences, provided the timing of dedolomitization in terms of early or late diagenesis has been inferred. This is based on the inference that as dedolomitization is a low temperature, low pressure near surface process (DeGroot, 1967) operating even today in the Recent (Al-Hashimi and Hemingway, 1973) older carbonate rocks, now becoming dedolomitized (late diagenesis) would certainly not indicate the presence of older unconformities.

Both fresh water (e.g. Shearman *et al.,* 1961, 1969) and sea water (e.g. Al-Hashimi, 1976) are considered to be the agents responsible for dedolomitization. The discussion to follow deals with two possible ways in which cyclic carbonate sequences dedolomitized (early) by fresh water can be used to infer the existence of hiatuses in stratigraphic sections.

VERTICAL DISTRIBUTION OF DEDOLOMITE CONTENT

Influx of fresh water from a landward source at the end of each progradational depositional cycle and after dolomitization will form dedolomites (the calcite which has replaced dolomite). The amount of dedolomite is expected to be much more in the supratidal as compared to the subtidal because of its proximity to source. Thus the vertical distribution of the dedolomites in a stratigraphic section is liable to show a variation of dedolomite content, being dependent on the quantity of fresh water invading the rocks at the end of each cycle. This variation, besides indicating various episodes of dedolomitization, i.e. early diagenesis, would also indicate the location of hiatuses in a stratigraphic section.

GEOCHEMICAL EVIDENCE

It is widely accepted that the whole rock (bulk) analyses of ancient carbonate rocks denote the sum of all geochemical changes that occurred in a rock. Strontium is the most extensively studied minor element in carbonate rocks. According to Veizer and Demovic (1974), early diagenetic dolomites contain higher Sr concentrations compared to the late diagenetic dolomites. They related this to the partition of Sr between aragonite and dolomite (early diagenetic) and between calcite and dolomite (late diagenetic). This in turn indicates that a higher concentration of Sr is expected in the early diagenetic dedolomites than those formed later on.

The loss of Sr during dedolomitization has been demonstrated in the French Jura (Shearman and Shirmohammadi, 1969) and in Carboniferous rocks in England (Al-Hashimi, 1976). Following Al-Hashimi (1976), solution composition can be obtained. High Sr compositions of dedolomitizing solutions for samples from areas where celestite, gypsum and anhydrite are absent would indicate the presence of metastable phases, i.e. the early diagenetic character of the dedolomites.

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A DISCOVERY OF EMERALD NEAR BUCHA, MOHMAND AGENCY

Light green beryl and emerald occur in talc-carbonate and carbonate-quartz rocks located about 200m north of Bucha village (34°24′ 30″ N; 71° 36′ E) in eastern Mohmand Agency. The crystals reach up to 10x5mm in size, however, large crystals are translucent, fractured, and poor in quality. Transparent and clear crystals of light green beryl and emerald are less than 3mm in length and are, therefore, not of a high commercial value.

The refractive indices of the light green beryl are $\varepsilon=1.575$, $\omega=1.583$; and those of the emerald are $\varepsilon=1.590$ (light bluish-green), $\omega=1.600$ (yellowish green). Absorption bands suggest the absence of V and Sc, and presence of Fe and, in the case of emerald, Cr in the specimens. The distinctly higher refractive indices of the Bucha crystals, when compared to ordinary beryl, are therefore due to the entry of Fe and Cr.

The Bucha emerald occurrence is similar to that of the well-known Mingora (Swat) emerald (cf. Jan *et al.*, 1981; Gubelin, 1982). The emerald host-rocks occur within the ultramafic member of the Skhakot-Qila-Utmankhel ophiolite complex and appear to be the alteration product of the latter along shear zones. Be and Al, along with Si and carbon dioxide, may have been brought by hydrothermal or pneumatolytic solutions, whereas Cr was provided by the host ultramafic rocks. However, the ultimate source of the solutions is not clearly understood. Further details of this occurrence will be presented in a later publication, but in the meanwhile it is recommended that altered rocks associated with ultramafic and mafic bodies of the region should be carefully studied for possible additional occurrences of emerald. The Gemstone Corporation of Pakistan is busy in investigation of the Mohmand area.

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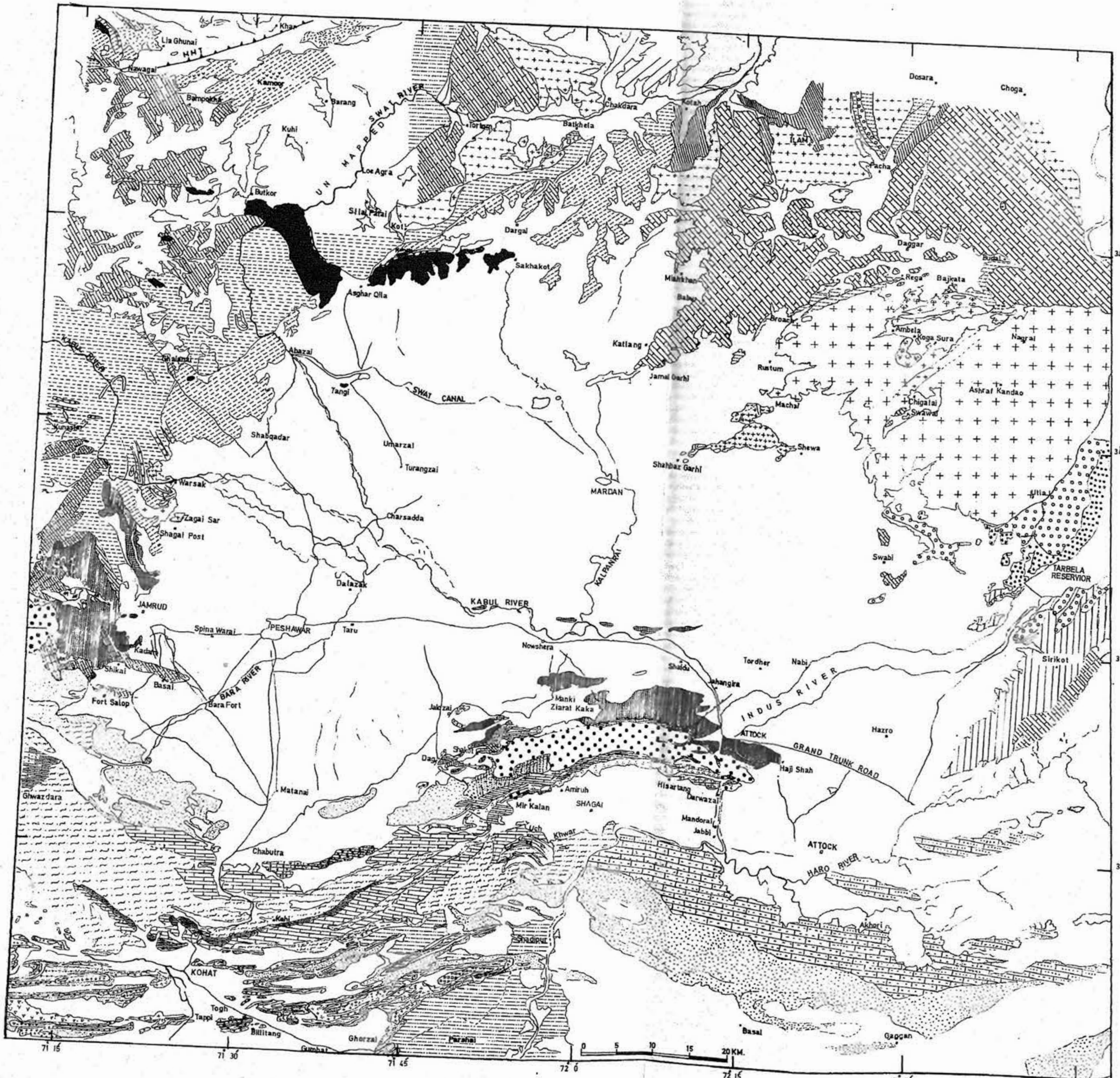

A GEOLOGICAL MAP OF THE SURROUNDINGS OF THE PESHAWAR PLAIN.

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BASE MAP: SATELLITE IMAGERY PLATE NO. 10 AND 16

COMPILED FROM PUBLISHED DATA WITH MODIFICATIONS BY:

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