Some petrologic observations in the "rock forest" of Central Peru

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Some petrologic observations in the "rock forest" of Central Peru

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Introduction

In the uppermost part of the Mantaro River valley of Central Peru, between the Pampa Junin and the Viuda Pass, an elongated region extending parallel to the general trend of the Andes is covered with dacitic tuffs. The extent of this oblong or oval strip is about 16 km, the width is about 6 km, and the elevation ranges from 4250 to 4700 m.

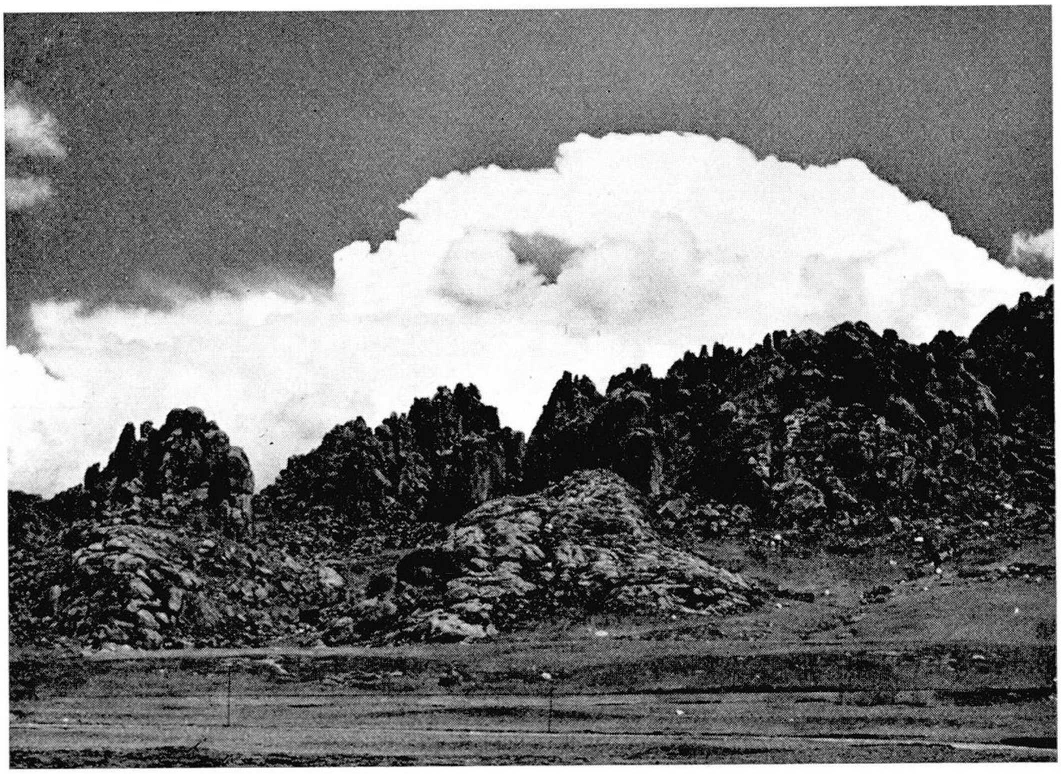

Figure 1. Part of the "rock forest" in Central Peru, 4300 m, on the Viuda pass road.

The tuffs grade westwards into volcanic breccias and agglomerates, a fact which suggests that the vent was close to the present western rim of the area. The deposition took place on a hilly surface with smooth slopes during the Quaternary Andean glaceation. The last glaciers produced relatively broad U-shaped valleys (figure 1). Glacial striæ can be observed half way up the rhyolitic ridges whereas the upper half shows columnar irregular structure; thus the name rock forest (spanish: bosque de piedras). The physiography and the general geology of this area has been described by MacLaughlin (1924) and Harrison (1953).

Age

The exact age of these tuffs is not yet known. However, two facts make it probable that they were deposited during a late interglacial period or during a later and weaker stage of glaciation. First, most of the crests of the present tuff ridges were not covered by the glacier. Secondly, the limestone surface on which the tuff was deposited can be interpreted as having been previously glaciated.

Composition

As shown in figure 4 the rock consists of plagioclase (An_{35-40}), quartz and biotite fragments in a glassy matrix which is partly crystallized. Scant criteria for welding, such as bent fragments etc. can be seen, but these criteria are not abundant and pumice is rare. The amount of welding, the range of composition and the location of vents or fissures could only be established through careful mapping and sampling, and through microscopic studies of many samples from the whole area.

Weathering

A remarkable feature of the rock forest tuffs are the honeycomb structures and the crustal weathering. Honeycomb weathering is a well known phenomenon and forms on almost every type of rock. Some years ago I took a picture similar to the one shown in figure 2, of a moist, somewhat protected NE-face of a large granite block near Nuoro, Sardegna.

The crustal weathering shown in figure 3 is known mostly from tuffs and agglomerates. In Australia it is called duricrust. If this crust were an organic body, the botanists or biologists would probably call this phenomenon a protecting action against further decomposition. The crust is harder than pure solid quartzite. Advanced weathering removes the crust mostly mechanically, through freezing and defreezing. A new crust is formed below the old one, at an average distance of 3 to 10 cm. The thickness of the crust itself is of the order of 1 to 3 cm. The material between the two crusts is soft and crumbly, and can easily be removed by wind and water.

No scientific explanation of the formation of such crusts has been found in the literature so far. Thin sections do not show any changes in the matrix because of the probable submicroscopic formation of one or more mineral phases. It is possible that the matrix of the tuffs contains

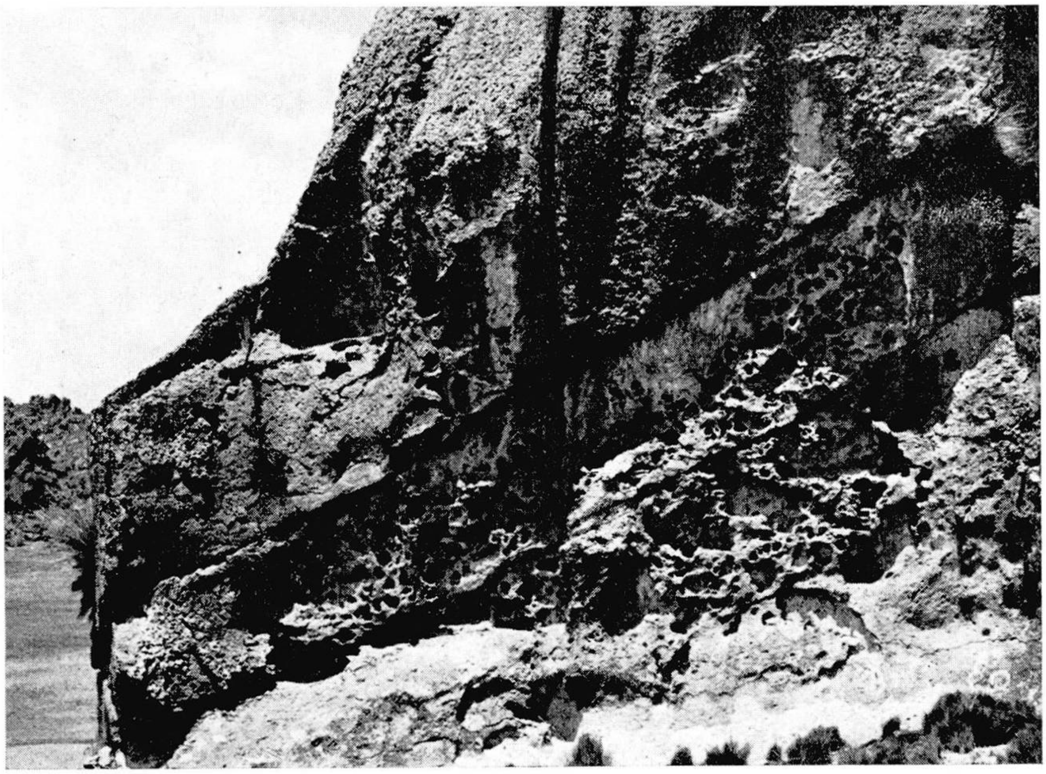

Figure 2. Honeycomb weathering, vertical joints, and layered structures in the dacitic tuffs of the rock forest.

$SiO_2 \cdot xH_2O$ which is activated by the temperature and moisture changes on the rock surface. A concentration of silica from the uppermost 3 to 10 cm of the rock may take place through the daily moisture and temperature changes which are strong at these altitudes. The average temperature change amounts to about -5 to $+20°$ C, but changes from -15 to $+30°$ C often occur. — This hypothesis of crust formation is being checked by X-ray analyses.

As seen from figure 2 the two phenomena of weathering can occur together. On somewhat protected rock faces where the moisture is retained longer than on others, the crust grades into honeycomb or cellular structures and may favor their formation. — Both these types of weathering can be observed as well on building stones in cities. The natural crust described in this paper should, however, not be confused with sulfatic crusts produced by H_2SO_4 from smoke in industrial areas. Weathering caused by insolation and crystallisation of the glassy or partly crystallized matrix of basalt is called "Sonnenbrand".

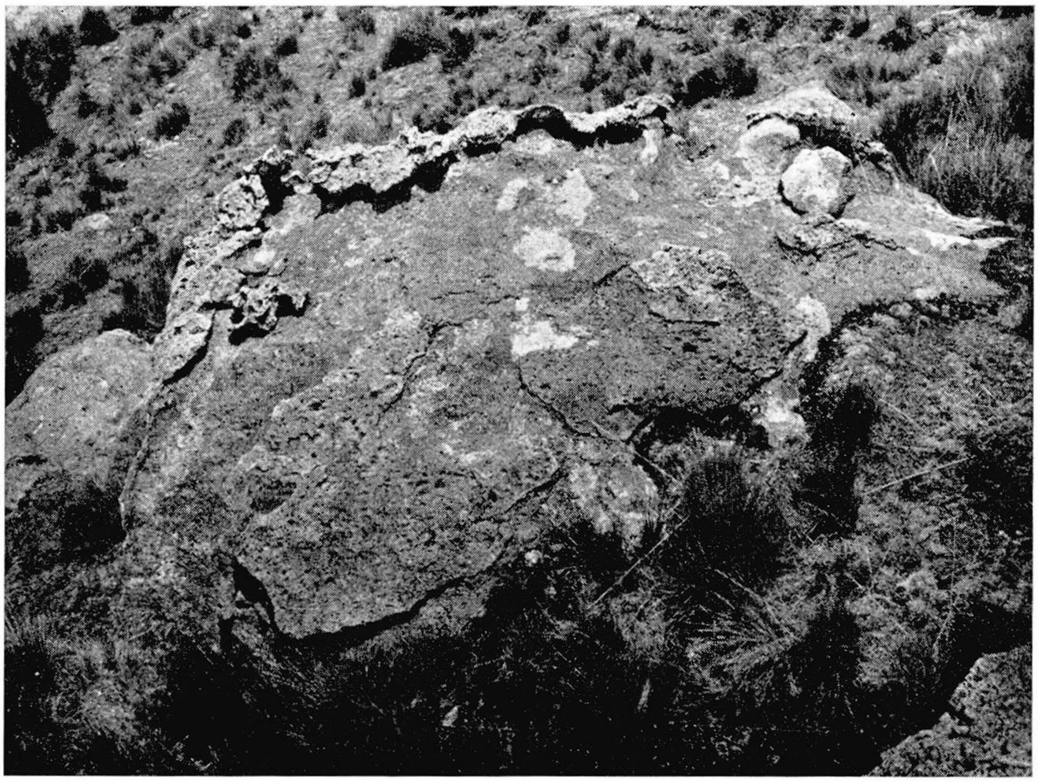

Figure 3. Crustaceous weathering of the dacitic tuffs. The oldest and second oldest crust was partly removed by water and wind, and the third one is just forming.

The irregular columnar structure of the rock forest is produced by the numerous vertical joints, one of which runs through the middle of the rock face shown on figure 2. This jointing is most likely due to cooling.

Pressure twins in plagioclase?

During the microscopic examination of these dacitic tuffs from the rock forest in Central Peru a peculiar kind of plagioclase twinning was observed in several thin sections. Some andesine fragments exhibit an echelon-type pattern of tension fractures. As far as observed so far in 12 thin sections from various portions of the tuff layer, in all these cases with echelon tension fractures, a clear superimposed second twinning system lies parallel to the fracture pattern zone (figure 4).

The regular coincidence of this possibly superimposed type of twinning with echelon tension fractures suggests that it could have been formed by the same forces that formed the sets of fractures. The writer has so far not found in the literature similar or equal criteria for natural pressure

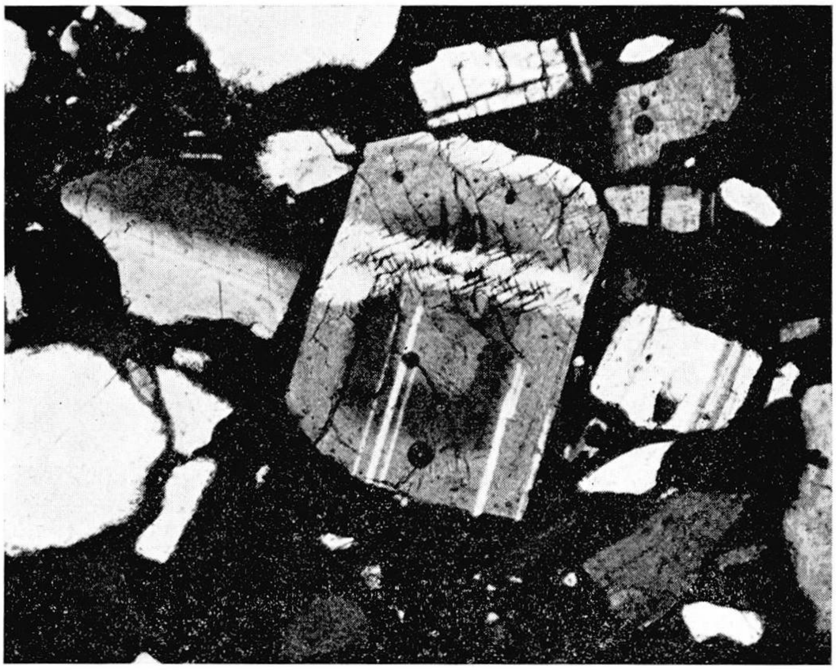

Figure 4. Superposed pressure twins in an andesine crystal in dacite tuffs from the rock forest.

twins in plagioclase. ALLING (1921) observed that the "Scotch plaid" twinning of microcline in a particular rock increases in frequency with closeness to a fault zone or shear zone. He also notes that microcline in rocks which do not appear to have been disturbed by mechanical means very often is untwinned and may be misdetermined as quartz. However, microcline twinning can be submicroscopic and the closeness to a fault or shear zone or the mechanical forces in a sheared rock may merely lead to a "Sammelkristallisation".

MÜGGE (1931) produced artificial pressure twins in anorthite. A simple experiment, first reported in 1952 (LAVES, 1952) shows that unstable pressure twins can be produced also in plagioclase. LAVES has observed them in K-albites ($Na_{0,8}K_{0,2}AlSi_3O_8$) and the writer produced them by pressing a needle on albite phenocrysts in spilites from Glarus, Switzerland (AMSTUTZ, 1954), and in oligoclase and andesine from peruvian rocks, such as the one described in the present paper.

LAVES has shown that the formation of stable pressure twins in plagioclase is a function of the degree of order-disorder regarding the Al-Si arrangement.

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