

ON DISEQUILIBRIUM IN MINERAL ASSEMBLAGES IN ROCK TYPES

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Introduction: The evidence of local disequilibrium of mineral assemblages have been cited by various authors (Ohta *et al.* 1968, Saxena *et al.* 1969). The present authors (Sen & Mukherjee 1971) have also reported compositional variation of plagioclase (An_{15} to An_{60}) from grain to grain in granites and grey quartzite gneisses on a scale of single thin section, while biotites remain mainly constant in composition in these rocks.

The present work is an attempt to give a thermodynamic interpretation of the compositional variation and to evolve out a feasible explanation for the disequilibrium in the rocks.

Interpretation: The temperature and pressure conditions as the factors to determine the coexisting phases of the system might be the same on a scale of hand specimen or on a thin section. If the phase rule shows more than one internal degree of freedom of a certain system, they may be revealed as a difference of chemical potential of certain components. Accordingly, some compositional variation among the coexisting phases caused by the difference of chemical potential may be expected in the system. The compositional variation of plagioclase needs two (2) internal degrees of freedom at least in a system of equilibrium (in igneous and metasomatic rock types).

In the case of metasomatic rocks some components should be considered as factors to determine the degree of freedom of the system. Therefore, the possibility to have internal freedom might be smaller in these metasomatic rocks than the rocks formed under the conditions of a closed system. Hence the tendency to reveal a large compositional variation is less.

According to Gibbs phase rule, the chemical potential should be the same in case of a certain component among coexisting phases under an equilibrium and without any internal degree of freedom of the system. The mass reaction shows that the partition ratio of certain elements among co-existing phases should be constant.

The data provided by Ohta (1968) and Sen & Mukherjee (1971) show that some phases formed under such equilibrium condition have some range of compositional variation. In the rocks having some degrees of internal freedom, the variation ranges of composition among coexisting phases are supposed to be too large to be explained by the internal freedom. These compositional variations are variations within a system concerned, and contradict the definition of chemical equilibrium. The system concerned there is so large to be treated as an equilibrium unit; that is why a smaller size of domain should be introduced. Accordingly, a very small domain which is constructed of a few grains of minerals is probably enough to have a chemical equilibrium. These small domains have presumably different paragenesis of minerals and also have different chemical potentials so as to give different partition ratios of certain elements for each small domain. The total rock represented on a scale of hand specimen or a thin section is thus an aggregate of these equilibrium domains. The total rock itself as a whole is not in the same equilibrium. The individual domains are in different equilibrium but the total rock containing these different equilibrium conditions are in disequilibrium as a whole. This idea of equilibrium domain is one

possible way of explanation on large compositional variations in the rock forming minerals.

Discussion: The compositional variation of a certain mineral in a rock which has got a few degrees of internal freedom of the phase rule is a strong indication of disequilibrium in a system under consideration.

A new parameter to indicate the degree of disequilibrium (D_d) is proposed as:

$$D_d = \frac{\text{Proportion of the maximum frequency (in \%)} }{\text{Range of compositional variation (mol \%)}}$$

Example:

Rock	Max.	An-content Min.	Range	Max. Frequency %	An of max frequency	An of submaxima
'X'	100	6	94	12.5	88	68-47-28

In this case $D_d = \frac{12.5}{94} = .13$ (Fig. 1)

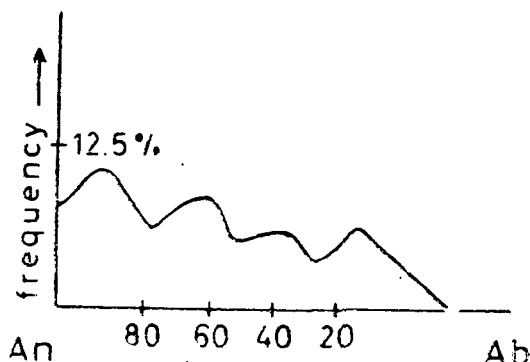


Figure 1.

At the present stage of development, it is not possible to give an exact value of the degree of disequilibrium for different minerals. But Ohta (personal communication) has suggested that the degree of disequilibrium of plagioclase in a system which has a degree of disequilibrium larger than 3.0 could possibly be regarded as nearly in equilibrium, while a system having a degree of disequilibrium smaller than 3.0 is not in a single equilibrium state. The latter is presumably a mixture of different mineral paragenesis or in disequilibrium. In the cases having more than one frequency maxima in their An-frequency curves, a smaller system of equilibria should be taken until the An-frequency curve has a single normal distribution curve with a large frequency maximum. The same kind of definition on the degree of disequilibrium may be possible for the other kinds of minerals, for example to use $Fe/(Mg + Fe)$ in some coexisting mafic minerals.

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A DISCOVERY OF NATIVE SULPHUR OCCURRENCE IN
ZAWAR LEAD-ZINC BELT, RAJASTHAN

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An occurrence of native sulphur body in seemingly incompatible association of metal sulphides has been recorded during the current investigation carried out in Zawar lead-zinc belt. This is the first reported occurrence of such a deposit in the Precambrian metamorphites of the Indian subcontinent.

The occurrence is localized in the eastern part of Mochia hill (Lat. 24°22'; Long. 73°42'06"), and only a part of it is exposed in the present working in a 3m × 3m area in a Drive of No. 8 Adit of eastern block of Mochia Mine; one sample of the sulphur rock gave on analysis of 54.5% sulphur.

The deposit occurs in the intrafacial contact of a dolomite and phyllite and is characteristically banded in nature. Native sulphur bands are interstratified with carbonaceous pelitic sediments varying in thickness from paper-thin laminations to massive bed (20 cm in thickness). The bands show concordance with the bedding of the associated rocks. Thin rhythmically alternating partings of carbonaceous pelites with an admixture of gypsum causes the banded structure. The sulphur layers are subvertical with east-west strike and are exactly concordant with the associated sediments. The multilayers of sulphur and the interstratified sediments show small-scale upright moderate to steeply plunging folds. The interstratified argillaceous sediments further show incipient development of strain-slip cleavage which trend obliquely to the strike of sulphur layers. There is a remarkable coincidence in structural elements in the multilayered sulphur body and the country rocks. Some sulphur layers are continuous while others are lenticular. The sulphur deposit is 1.5 m in thickness. The striking feature of the deposit is that it contains identical litho-units both on the hangingwall and footwall sides. On the hangingwall side, the sulphur is overlain successively by carbonaceous pelites, gypseous shales and ferruginous pelites while in the footwall side, the sulphur body is underlain by carbonaceous pelites followed by gypseous shale and ferruginous shales. This regularity in the disposition of the litho-units in the form of concentric bands around the native sulphur body suggests a weak but distinct mineral zoning (Fig. 1). Pyrite and sphalerite occur both to the east and west of the sulphur deposit and show distinct decrease in the level of concentration with the approach of sulphur body, while the sulphur body characteristically maintains the same strike as that of the metal sulphide deposits. Transition from metal sulphides