LETTER TO THE EDITORS

**A Revision of Theoretical Interpretation of
“Magnetic Susceptibility of Compressed Rocks”.**

In his paper entitled “Magnetic Susceptibility of Compressed Rocks” (Nagata 1966), the present writer made a somewhat misleading explanation in regard to a mathematical expression of the average energy of an assemblage of uniaxial magnetic domains oriented at random. This letter attempts to correct the misleading expression and re-interpret the mathematical problem in a more proper way.

In regard to individual domains whose axis of minimum anisotropy energy (i.e. the easy axis) makes an angle φ with the direction of a magnetic field H which is parallel to the axis of uniaxial compression σ , the total energy E per unit volume was expressed by eq. (9) in the original paper, as

$$E(\varphi) = K_u \sin^2(\theta - \varphi) + \frac{3}{2} \lambda_s \sigma \cos^2 \theta - J_s H \cos \theta, \quad (1)$$

where θ denotes an angle between H and spontaneous magnetization J_s . Eq. (1) is not a general expression of the total energy in the case of no limitation for the direction of J_s , but it represents the energy at a state partly fulfilling a necessary condition for the minimum value of the total energy of individual domains, because vector J_s is assumed to lie on a plane formed by vector H and the easy axis. Such a condition should certainly hold in individual domains, whence one freedom regarding angle θ remains in eq. (1) as a variable for determining the minimum energy condition. Therefore, the average value of the total energy with respect to random distribution of the direction of easy axis under this condition will be expressed by eq. (11) in the original paper, namely,

$$\bar{E} = \frac{K_u}{3} (1 + \cos^2 \theta) + \frac{3}{2} \lambda_s \sigma \cos^2 \theta - J_s H \cos \theta. \quad (2)$$

In the sense of interpretation mentioned above, the mathematical expressions and the results obtained in the original paper are correct.

Kern (1961) started his theoretical treatment of the same problem from the same assumptions as the writer's in regard to the energy state of individual domains. In his work, however, the averaging of direction of the easy axis was made for the general case that J_s does not necessarily lie on a plane formed by H and the easy axis; in other words, a necessary condition for the minimum energy of individual domains is ignored. If this kind of averaging process is made, $\bar{E}$ is expressed by

$$\bar{E} = \frac{K_u}{3} + \frac{3}{2} \lambda_s \sigma \cos^2 \theta - J_s H \cos \theta,$$

which does not explicitly contain a term of anisotropy energy dependent on θ , as Kern, himself, pointed out.

It may have to be emphasized, therefore, that eq. (2) in the present note (eq. (11) in the original paper) satisfies one of the necessary conditions of minimum energy of individual domains, and thus the average state of anisotropy energy is introduced as a function of θ . In an exact calculation, the minimum energy state of individual domains must be averaged for all possible values of φ . In the writer's approximation, a direct average of eq. (1) with respect to φ leads to eq. (2). Hence, eq. (3) represents the first approximation and eq. (2) does the second one of the average value of the total energy.

References

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