stressfields. However, what other forces would be available? All disturbances of the rheological equilibrium, being either physicochemical or thermal in origin, are in fact gravitational deviations from the hydrostatic equilibrium. This thesis is sustained, for instance, by Ramberg (1967).

Thirdly, Metz remarks correctly that it would be rather senseless to make a distinction between primary and secondary tectogenesis, when one considers the geodynamics of the deeper structural levels (Stockwerke). But indeed,this distinction is not made by the undation theory. The undations, with their primary- and secondary tectogenetic effects, are near-surface phenomena (see also Van Bemmelen, 1967, table II, p.87). In deeper structural levels only mass-circuits can be distinguished, the potential energy of which has a gravitational character.

In conclusion, it can be said that the second edition of Metz' textbook has the same qualities of its predecessor and that it is up to date, so that it can be recommended to students and teachers in hard rock geology and general geology.

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Gravity, Deformation and the Earth's Crust, as Studied by Centrifuged Models. H. Ramberg. Acad. Press, London and New York, N.Y., 1967, 214 pp., 125 illus., £2.17.6.

There is a real need in the science of tectonophysics for a book which analyses the role of gravity in tectonic deformations. The concept of "gravity tectonics" has for a long time and with increasing emphasis been advanced by many geologists. However, their approaches to this idea were generally rather intuitive, so that quite often, they were misunderstood by other earth-scientists. The cause of the hesitancy to accept the mechanical model of gravity tectonics as a general basis for the explanation of geodynamic processes, was the lack of a well-thought-out theoretical analysis and mathematical formulation.

Now Ramberg's book is a valuable attempt to fill up this gap.

According to the Preface, this book might be of use "to seasoned earth-scientists as well as to those who are struggling to reach that stage". The reviewer can support this recommendation, although - in his opinion - the theoretical analysis is rather too short and the many mathematical formulas (138) in the book are often incomprehensible because their derivation is not given. One has to go back to the author's original papers for a more complete mathematical treatment. As this being the case, the question arises,

why the formulas are given at all since the gist of the book can be understood without them?

As an example for the incompleteness of the mathematical treatment, we can give eq. 56 on p.66, which is Smoluchowski's equation for the wavelength of lateral stress buckless. It is not mentioned that this equation is valid only for plates which are very long in relation to the dimension of the buckles. This is rightly stated in Ramberg and Stephansson (1964), in which we read (on p.102, 9th sentence from bottom): "Assume that l is very large as compared with the wavelength λ...".

In the present book, however, Smoluchowski's equation is used for a comparison with experiments for which it is not strictly valid. The restricted length of the plate causes certain deviations from the theoretical expectations. This is not so apparent in the book, because the author mentions nowhere the length of the plate and the wavelength of the buckles in the experiments, taken from the paper of Ramberg and Stephansson (1964) without closer comments.

The application of a centrifuge technique means a great advance in tectonic experiments. In the centrifuges used by Ramberg the ratio between the centripetal acceleration and the acceleration due to gravity has at present a maximum value of 3,000. This means that rather firm substances can be used for the construction of models. Thus this can also be made for geodynamic processes of long duration and great size more realistic models. In fact, the model substances can be 3,000 times stronger than the firmness required according to the scale theory for the materials in the corresponding non-centrifuged experiments.

The outcomes of centrifuged experiments on such geodynamic processes are given as the buoyant rise of magmas, subsiding denser bodies, orogenesis, the formation of the Caledonides, submarine ridges and rift-valleys, and convection currents. In the Appendix (pp.179–200) an analysis of the dynamics of various models with unstable stratification is given.

Ramberg comes to the important general conclusion that "...virtually all tectonic features and deformation structures are produced by adjustment of masses in the field of gravity and the resultant reduced gravity potential" (p.20), and that during tectonic processes, caused by volume change associated with phase transitions, thermal expansion or elastic compression of condensed materials do occur ..."but they are probably of quite limited significance" (p.22).

Moreover, the author introduces a new concept, that of the "mechanical potential", which is the sum of the gravity potential and the spatial potential of a unit of mass. In this way, for instance, also buoyant diapiric masses represent adjustments in the field of gravity, the sum of the gravity potentials of the internal and the external system being a net drop in the gravity potential of all masses involved in these interdependent circuits of matter. It is the gravity potential that furnishes the power of the deformation of the upward diapiric movements.

In relation to the problem of convection currents, Ramberg introduces the concept of "heterogeneous convection" associated with changes of phase. The reviewer wants to remark that in Ramberg's definition of heterogeneous convection there is still the premise of chemical homogeneity for the reversable processes of thermal convection systems. If there is also an inhomogeneity in the bulk composition of the various parts of the flow-system, this

makes it a thermodynamically irreversable process. In such cases the reviewer prefers to speak simply of "mass-circuits", avoiding the physical concept of convection which is strictly based on differences in temperature. But it might be convenient to enlarge the applicability of Ramberg's term "heterogeneous convection" to all those mass-circuits which occur in chemically inhomogeneous fields. This terminology might be preferable, because of the fact that the term "convection" is nowadays already generally indiscriminately used by earth-scientists, whether they deal with reversable or with irreversible mass-circuits. If this enlarged definition would be accepted, diapiric movements of magma or rocksalt for instance might also be called heterogeneous convection systems at a small scale.

The book has a well-selected although not very exhaustive bibliography; papers by Gignoux and some others who did pioneering work in the field of scale experiments might have been mentioned. The Subject Index is rather short and even incomplete. For instance, terms of some newly introduced concepts, such as "spatial potential" and "heterogeneous convection" are lacking.

In conclusion it can be said that this book should be read by al those who occupy themselves with problems of geodynamics and that it is recommended as supplementary reading for students in tectonics and structural geology.

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