Foreword

The book that you have in your hands is most unusual. It results from about 15 years of work, two European Research grants (ERC), and the work of a team of about thirty researchers, permanent and non-permanent, under the guidance of Patrick Cordier. It deals with a field, minerals physics, which relatively small compared to the field of materials science, and even to the field of materials plasticity. And in spite of that, or perhaps because of that, it provides a very convincing example of "investigator-driven research", built on a long-term vision, and allowing a true cross disciplinary approach to a deep understanding of fundamental issues.

It is obvious to anyone who has practiced science, that long-term thinking and freedom are essential to scientific progress. This is true in any field. It is threatened everywhere, either by short-term pressure driven by profit, or by the so-called societal issues driven mainly by politics, or by fashion which decides what is worth studying and what is not. The ERC grants provide a rare example of resistance against these deleterious trends in research funding. And the present book is a magnificent proof of the value of such an approach for the progress of science.

The book deals with mineral physics, and more specifically with mineral plastic flow, but it is perfectly accessible and enjoyable to any materials scientist.

It starts with three chapters providing the basics needed to read the book. The one on plasticity and defects is a synthetic description of the classical micro-mechanisms for plastic flow in crystalline and non-crystalline solids. The second one describes for the layman in geology the structure and dynamics of the Earth, its amazing variety in terms of minerals and in terms of temperature, pressure and strain-rate conditions. And the third chapter presents the techniques, both experimental and computational, which are used. It is well worth noticing that this third chapter sets the level at which the materials science presented in this book stands: the most up-to-date tools are applied to the most exotic materials for a metallurgist, and the most important ones for a geologist!

The next three chapters take us in a fascinating journey into dislocation glide in minerals, into the role of climb of dislocation in creep, into the structure and dynamics of grain boundaries and their coupling with applied stress, and finally into the amorphization under stress. For a reader interested in learning about mineral materials, the variety of topics treated, alternating very subtle experiments and up-to-date simulations, is a delight. For a reader with a comparatist state of mind, there is a constant incentive to compare them with more classical materials, with ball-milling amorphization, or with recovery processes under stress, which could benefit from the approaches developed here. The last time I had a similarly stimulating reading at the frontier of my own field in materials science was with the classic "*Creep and Fracture of Ice*" by E.M. Schulson and P. Duval

The last chapter, labelled "Implications", brings us back to the macroscopic scale, to the behavior of the mantle. Then all the findings presented in the previous chapters find their place in a geological picture of mantle dynamics, giving a very convincing story, from the laboratory test to mantle conditions, from the atomic structure of defects to the macroscopic behavior, and showing the relevance of stress-induced amorphization on rheological behavior.

This unusual book is a true example of cross disciplinarity, not the one which simply uses one discipline to serve the purpose of the other, but the one in which both disciplines benefit from the collaboration, opening new questions, and developing new tools. This is clearly what the two ERC grants have made possible. And we must be happy that Patrick Cordier and his team have made this adventure accessible to outsiders, together with the proof that long term "non fashionable" research is still possible.

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