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Magnetic Fabric: Methods and Applications

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an overview of the theoretical problem, with emphasis on the differences in approach to modelling for the near-field and far-field zones around underground openings. Next, the governing equations for flow in porous and fractured rock media are discussed, which are needed for the development of flow models. This is followed by general discussion of the boundary-element method. In the second half of this chapter, the models are applied to particular tunnel geometries for migrants such as dichlorvos and zinc.

The appendix contains a list of inactive and active mines in Belgium, Denmark, Finland, France, Greece, Ireland, Italy, Luxemburg, Portugal, Spain, Sweden, Nederland and the United Kingdom. The list provides data about the mine operator and the annual mine capacity in cubic tonnes of mined material.

In general, the first three chapters of the book contain a variety of data that can be used by non-specialists to acquaint themselves with the problems associated with underground storage of hazardous wastes. The last chapters treat stress and flow models and are relevant to qualified engineers who have previous experience in hydraulics calculations and applications of numerical models. The book is richly illustrated but some of the illustrations are detached from their context in the book. Little is said about data collection procedures and the availability of data needed for building the numerical models. My personal opinion is that this book contains a good introduction to the procedures and practices of hazardous waste storage but it is most suitable for qualified geo-engineers rather than students.

Magnetic Fabric: Methods and Applications

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The history of a rock's formation and deformation is recorded, in part, by the alignment of its constituent minerals. Petrofabric, the study of the preferred alignment of minerals and rocks, is used as a proxy measurement for paleocurrent directions in sedimentary rocks, emplacement flow directions in igneous rocks, and strain directions in deformed and metamorphosed rocks. These proxies do not necessarily mimic their targets, so a great deal of clever field work, lab work and analysis must be done to determine their applicability.

Most techniques used to measure petrofabric (pebble long-axis counts, universal stage optical microscope measurements of oriented thin sections, and x-ray or neutron goniometry) are tedious and time consuming and only account for the orientations of small numbers of grains. In contrast, measurement of anisotropy of magnetic susceptibility (AMS) is a rapid and sensitive petrofabric tool. It takes less than 3 minutes a sample, and integrates the fabric of all the grains in a core specimen.

Application of magnetic anisotropy is often complicated because the relationship between magnetic fabric and petrofabric is not direct. In rocks that host ferromagnetic minerals, such as magnetite, the magnetic fabric signature is dominated by those grains. Iron oxides and sulfides are sensitive to the primary, metamorphic and environmental history of the rocks, leading to both the strength but also the complexity of the method. In rocks lacking a ferromagnetic component, the alignment of paramagnetic (mostly silicates) and diamagnetic (mostly carbonates and quartz) minerals is observed. Usually the major axis of the AMS ellipsoid is parallel to crystal lineation, and the minimum axis is perpendicular to foliation. The magnitudes of the ellipsoid axes, however, depend, in a complex way, with the alignment forces such as finite strain magnitude.

In 1954, John Graham published "*Magnetic Susceptibility Anisotropy, an Unexploited Petrofabric Element*". On the golden anniversary of that trail-blazing publication, the Geological Society of London published its Special Publication No. 238 on "*Magnetic Fabric: Methods and Applications*". This book reveals the development of this research field over the last 5 decades. There are papers on the history of the method, its physical foundations, instrumental aspects, and current examples of how anisotropy results can be applied to many areas in the earth sciences. The papers do not shy away from presenting important limitations and unresolved problems.

Based on special sessions in 2003 at the Joint Assembly of the EGS-AGU-EUG in Nice and the AGU Fall Meeting in San Francisco, this volume is more than a collection of unrelated current research papers. Several reviews are featured, including the fine overview by the editors. The centrepiece is Borradaile and Jackson's 62 page review of "Anisotropy of magnetic susceptibility (AMS): magnetic petrofabrics of deformed rocks", including an extremely useful 3 page glossary. This paper is rigorous but fully readable. It also introduces a clever new polar plot to display fabric data.

The book is divided into 5 sections. The first, "Magnetic Fabric Characterization Methods and Mineral Sources" (6 papers), includes reviews on laboratory methods (Potter) and statistical methods (Jezek and Hrouda). The second section, *Sedimentary Fabrics*, features 6 case studies. Unfortunately, only one of these deals with the important application of depositional flow directions (Matasova and Kazansky's impressive study on Siberian loess formation including analysis of wind direction). The rest investigate deformation recorded in sedimentary rocks, and thus should be placed in one of the last sections.

The next section on *Igneous Fabrics* is quite humbling for the method. While the study by Petronis et al. concludes that magnetic fabrics are parallel to emplacement directions in a lacolith, the other 3 papers suggest that magnetic fabrics in igneous rocks are, at best, complicated functions of flow direction, mineralogy, and boundary conditions. In contrast, the fourth section on *Tectonic Fabrics* (6 papers) includes several successful studies for magnetic methods. I would like to highlight the paper by Chadima et al. who compare neutron goniometry to low and high field magnetic fabrics on deformed Bohemian metasediments.

The last section, on *Complex Fabrics, Superposition and Alteration* has 4 papers revealing difficulties in magnetic methods on rocks with rich geological histories. A particularly impressive work (De Wall and Warr) used heat treatment on the rocks to oxidize siderite in order to the more magnetic magnetite to make better measurements. They applied a paleomagnetic tilt test to the magnetic fabrics to establish the relative timing of diagenesis and deformation.

The book includes most of the significant members of the magnetic fabric community. Two authors stand out in the collection: František Hrouda with four papers, and Graham Borradaile with three. They have been leaders over the recent decades, and it is good to see them properly represented here. I am sorry not to see a paper by Ken Kodama or his colleagues who have been working on magnetic fabrics and the deflection of magnetic remanence (e.g. inclination shallowing) which has an important application to paleomagnetic studies.

This Geological Society Special Publication is a substantial book, much larger than their typical 200 to 400 pages. While it may be too expensive for individuals to purchase, it should be included in all earth science library collections. Researchers in all fields concerned with rock fabric and deformation will find it useful.

Fine Wine and Terroir: The Geoscience Perspective

Edited by R.W. Macqueen and L.D. Meinert
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There is an apocryphal story that many readers may have heard, about the geology student (sometimes a geochemist) whose summer project involved catching lake trout so their livers could be collected for geochemical analysis. Regardless of the feasibility of this method for identifying exploration targets, or of whether or not one enjoys angling, the implication is clear – nice work, if you can get it. A similar sentiment arises when admiring photographs of the sunny climes and spectacular scenery that provide the backdrop for diverse studies of world viticultural regions presented in *Fine Wine and Terroir: The Geoscience Perspective*. Certainly, the element of humour is not lost on some of the authors, who, for example, may point out that wine samples from studied vineyards were tested to fully understand the meaning of terroir, and that "some samples required repeated evaluation" (Meinert and Busacca, p. 51). I have a suspicion that my declared fondness for wine led to my being asked by a certain *Geoscience Canada* co-editor to pen this review. Be that as it may, it has led to an appreciation of the vine-growing/wine-making science (art?) at a whole different level, and one might say that I have become a terroir-ist. But for the uninitiated, an explanation of what is meant by terroir is in order.

The term "terroir" has its origin in Burgundy, and has no precise English translation, or, stated differently, a translation may potentially run to several sentences. It encompasses all aspects of the physical environment of vine cultivation underlying and shaping the character and quality of the wine including meteorological, physiographic, pedological, geological and (often) viticultural controls. The significance of terroir may be understood by the simple occurrence of two adjacent vineyards that share most aspects of physical environment and viticulture, but produce very different wines. A corollary is that any given terroir may vary in quality from, say, a warm dry year to a cool wet year, where vineyard A produces better wine under the former conditions, and vineyard B better wine under the latter conditions. Outside of France, the concept of terroir is commonly misrepresented or misunderstood, and geologic and physiographic considerations may be ignored. In France, no such confusion exists, the French having had thousands of years of hands-on viticultural experience in matching particular grape varieties with specific settings. In one of the subdistricts of Burgundy, for example, *vignerons* have known for hundreds of years where the vineyards that produce top-quality wines should be located; it is only recently that geologists have shown that, in this instance, the borders of vineyard designations correspond almost exactly with stratigraphic boundaries. As testament to the importance attached to the subsoil/bedrock, the French Appellation Laws of 1935 protect the quality of winemaking regions under the auspices of L'Institute National des Appellations d'Origine, whose team of six scholars includes two geologists.

Fine Wine and Terroir is a collection of seventeen papers and two short "overview" articles; thirteen of these have previously been published in *Geoscience Canada* as part of the "Geology and Wine" series, whereas the remaining six are taken from the Simon J. Haynes special session, held at the GSA annual meeting in Seattle, in 2003. Simon Haynes is widely considered to be the godfather of terroir studies, at least on this continent, and the book is dedicated to the former Brock University Earth Sciences Department professor, who served as founding editor of the "*Geology and Wine*" series until his death in 2002. Seven papers describe the terroir of specific grape-growing districts, includ-