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Editorial

Editorial for Special Issue "Heavy Minerals"

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This special volume, published 13 years after the monumental volume "*Heavy Minerals in Use*" edited by Maria Mange and David Wright, demonstrates that the use of heavy minerals as provenance tracers is alive and in full health. This collection of scientific contributions is born as an ideal continuation and update of that milestone of provenance studies given to us by Maria as a gift a few years before her untimely death. For this reason, this volume is opened by a testimony by John Dewey, one of the greatest protagonists of the plate tectonics revolution, who worked on many geological problems with Maria through some 25 years.

The methodological articles and case histories collected in this book aim at documenting the main developments of the discipline achieved during the last decade, which has seen the birth of new concepts, new technologies, and new applications in heavy-mineral studies.

The first part of the volume includes papers embracing general themes. To emphasize the importance of artisanal laboratory processes, which are the starting point of any mineralogical research, the opening article is a technical handbook by Sergio Andò (Laboratory for Provenance Studies, University of Milano-Bicocca) [1], conceived as a state-of-the-art simple practical guide for students of any level willing to tackle the challenges posed by mineral separation from rocks and loose sediments of any grain size from silt to sand. The second article by Eduardo Garzanti and Sergio Andò [2] illustrates the general criteria that should guide provenance studies based on heavy-mineral suites, from the problems posed by sampling in the field and the choice of the size window for analysis to the complex issues associated with data interpretation. These two articles condense experience gained through the last decades and aim at providing simple useful advice using a direct, and at places colloquial and entertaining language including anecdotes, which are difficult to find in traditional scientific literature forcibly characterized by a stern, more official attitude.

The articles that follow include a guide to data analysis using *provenance*, a software package within the statistical programming environment R, by Pieter Vermeesch (University College London) [3], one of the leading experts in the field of statistics applied to geological data. The aid of statistical techniques has become indispensable at a time when the flourishing of new technologies allows the collection of bigger and bigger datasets that make objective interpretation by visual inspection impossible. Next, the article by Keno Lünsdorf and colleagues of the University of Goettingen [4] presents the most updated report on the semi-automated identification of detrital minerals by Raman Spectroscopy, a user-friendly tool that allows targeting detrital minerals as small as a few microns in diameter, thus opening up a new frontier for provenance studies. The validity and robustness of Raman spectroscopy is demonstrated in the following study by Danilo Bersani and colleagues of the Universities of Parma and Milano-Bicocca [5] focusing on calcic amphiboles of the tremolite-actinolite series, and articles that show how this innovative technique allows a rapid and accurate identification and subtle discrimination within mineral series. Last but far from least, the first part is concluded by the article by Andrew Morton and Paula MacGill (HM Research and CASP Cambridge) [6], who summarize their pluri-decal experience on the application of heavy-mineral analysis for the correlation of hydrocarbon reservoirs and in general of strata barren of age-diagnostic fossils cored in oil boreholes.

The second part is dedicated to case histories and begins with the regional study by Wendong Liang and co-workers of the University of Milano-Bicocca [7], dealing with the geochemical characterization at the scanning electron microprobe of the four most common mineral groups in orogenic sediments (amphiboles, epidotes, garnets, and pyroxenes). The article focuses on the provenance of Thal Desert sand, an eolian dune field in central-northern Pakistan formed by Indus River sediments derived from the western Himalayan syntaxis at a time of dry climate and weak monsoon following the Last Glacial Maximum. The two companion papers that follow, by Laura Borromeo, Eduardo Garzanti, and co-workers including Christian France Lanord (CRPG, Nancy) and Annette Hahn (Marum Center, Bremen) [8,9], are dedicated to provenance analysis of silt and sand deposited on the Bengal shelf. These sediments represent the link between Ganga and Brahmaputra bedload and suspended load and Bengal Fan turbidites in the largest sedimentary system on Earth. Another two studies are dedicated to the two largest sedimentary systems of China, represented by the Changjiang River (Yang Tze) e Huang He (Yellow River). The first article, by Wei Yue and co-authors of the Jiangsu Normal University (Xuzhou), Tongji University (Shanghai), Binzhou University (Binzhou) and Ludong University (Yantai) [10], is a quantitative analysis of textural and compositional modifications of detrital sediments used to unravel the sediment provenance and environmental changes in the Changjiang basin. The second article, by Zhao Wang and co-workers of diverse universities in China, United States, and Italy [11], investigates the early evolution of the upper reaches of the Yellow River based on heavy-mineral and REE geochemical signatures recorded in the sequence of nine terraces formed during the progressive incision of the Yellow River in the last 1.7 Ma. The volume is closed by the article by João Cascalho [12], a regional study of heavy minerals from the Portuguese continental margin, that points to the existence of contrasting sources, namely felsic igneous and metamorphic rocks and igneous basic rocks next to dolomitic limestones affected by thermal metamorphism. This article also integrates issues presented originally in the *Heavy Mineral in Use* book edited by Maria Mange and David Wright.

Conflicts of Interest: The author declares no conflict of interest.

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