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PREFACE

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"Progresses in deciphering structures and compositions of basement rocks"

The information provided by the analysis of structures and compositions of metamorphic and igneous rocks is the key for understanding and reconstructing the evolution of the Earth's lithosphere. Indeed, the study of basement rocks has been constantly stimulating an exciting debate within the geological community. New frontiers have been opened in this field by adopting multidisciplinary approaches, based on multiscale structural analysis and study of the chemical and isotopic composition of rocks and minerals.

Over the last twenty years, structural analysis, geochemistry, geochronology, and experimental petrology benefited from fast improvements of analytical techniques. Such quantitative multidisciplinary approach has contributed to develop new ways of thinking about the tectono-metamorphic evolution of basement complexes.

This special issue deals with the integration of field and laboratory analytical techniques that is indispensable to provide modern interpretations on tectono-metamorphic evolution of crystalline basement units within mono- and poly-cyclic belts. Indeed part of the papers here collected are dedicated to methodologies and pioneering techniques recently adopted to furnish successful strategies in the study of igneous and metamorphic rocks and their constituting minerals. Other contributions are devoted to illustrate the most recent progresses in the knowledge of the metamorphic and igneous complexes that crop out in the Italian regions, with particular regards to the Alps, Sardinia, and Calabrian-Peloritani Orogen.

Most of the following contributions contain topics that were originally presented during the Workshop "The "art" of deciphering structures and compositions of basement rocks: research advancements and investigation strategies in the study of crystalline basements" held at the SGI-SIMP 2014 congress in Milan (Italy) that inspired the compilation of this volume. The first two contributions focus on the regional geology and tectonic evolution of two important crystalline complexes of Italy. The first contribution by **Cruciani et al.** presents a new model of tectono-metamorphic evolution of the northern Sardinia crystalline basement, within the broader framework of the South European branch of the Variscan belt. The formulation of

their model derives from a rigorous analysis and a thorough discussion of the structural, petrological and geochronological data existing in the literature. **Cirrincione et al.** provide an up-to-date review of the Calabria-Peloritani Orogen integrated with novel field and laboratory data. On the basis of these data the authors describe the overprinting relationships of the Variscan and Alpine orogenic record and their heterogeneous distribution throughout the different massifs that constitute this orogen. Finally for the crystalline massifs juxtaposed within this orogenic belt, a new intriguing palaeogeographic interpretation is provided.

The following contributions describe the interplay of different field and laboratory analytical approaches and show case studies.

Gosso et al. present a working strategy to find back the polyphase history recorded by crystalline basements involved within the evolution of subduction-collision zones. The method relies upon synergic multi-scale analysis that, exploiting the rock memory, attempts to detect geologic traces, such as structures, metamorphic assemblages, mineral chemical compositions that survived later re-working, because of heterogeneous partitioning of deformation and metamorphism. Crystalline basement units that share a common deformation and metamorphic history (i.e. tectono-metamorphic units) can be individuated following the strategy shown in the paper. Application of the method and results are presented by means of regional examples from the western Alps and southeastern Canadian Cordillera. **Bartoli et al.** present a review of the studies carried out on the melt and nanogranite inclusions hosted in peritectic minerals from the migmatitic terrane underlying the Ronda peridotites, in southern Spain. This study aims to illustrate the high potential of these tiny inclusions of providing a wealth of microstructural and compositional constraints on HT metamorphism and mechanisms of crustal melting. The adopted research strategy includes microstructural and chemical characterization of both melt inclusions and host rocks at different melting stages, thermodynamic modelling of the melting process, as well as a novel experimental approach proposed to re-melt nanogranites in order to successfully retrieve the anatectic melt compositions. **Langone and Tiepolo** present a U-Th-Pb multi-phase approach to reconstruct parts of the polyphasic deformational and chemical evolution of amphibolites and metapelites of the Ivrea-Verbano Zone in the Southern Alps. They obtain results that indicate a complex evolution of this basement and stress the importance of using a multidisciplinary approach and multiple geochronometers for a successful reconstruction of the tectono-metamorphic evolution of basement rocks and geodynamic processes at the lithosphere scale. **Rebay et al.** propose a new use of the study of the chemical zoning in Cl-bearing amphiboles in different orogenic contexts as tracers of circulation in extensional tectonic regimes, as can be reconstructed through careful microstructural studies on samples from the western Alps and northern Apennines. The authors also suggest that such fluids can then be successively recycled in subduction zones, influencing the subsequent tectono-metamorphic evolution. Finally, the review article on the Ar-Ar geochronology of mono- and poly-metamorphic basement rocks, by **Villa**, carefully addresses systematic aspects of the K-Ar decay system in different mineral chronometers, such as amphibole, biotite, muscovite/phengite, and K-feldspar that

are common P-T-fluid sensitive constituents of the crystalline rocks. The author especially indicates that mineral chronometers frequently behave as hygrochronometers rather than as T-dependent geochronometers, due to higher dissolution/recrystallization rates than diffusion rates. The author concludes that the ^{39}Ar-^{40}Ar technique can produce accurate results, when it is associated with high-resolution petrography and petrology.

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The Guest Editors

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