Critical metals are fundamental to many 21st century processes and technologies. These elements are essential for maintaining and improving future quality of life, including many high-technology yet low-carbon industries. Two factors have been used by the NRC (National Research Council) to rank criticality: the degree to which a commodity is essential and the risk of supply disruption for the commodity (Verplanch and Hitzman, 2016). The European Union has identified twenty critical raw materials as critical metals (Ec, 2015). Many of these critical materials (including Rare Earth Elements (REEs), Platinum Group Elements (PGEs), Magnesium, Niobium, Germanium, Indium, Gallium, Cobalt, Borate, Tungsten, Fluorspar are important for high-technology, environmental protection and military applications, but vulnerable to politically or economically driven fluctuations in supply (Pirajno, 2009; Laznicka, 2010; Charalampides et al., 2015; Fernandez, 2017). Tin, Molybdenum and Lithium) are included as critical metals by several countries (e.g. Australia; Skirrow et al., 2013). Of course a number of other metals, which have not been assessed as critical, are also of significant importance for modern technologies – these include some of the alloy metals such as chromium, nickel and molybdenum.

Many of the critical raw materials are by-products of base metal mining, but they may have economic values greater than the associated base metals, in examples such as Mo in porphyry copper deposits, REEs in iron-apatite ores and Ge in lead deposits (Richards, 2003; Daliran and Stosch, 2005; Laznicka, 2010). Iran is an interesting country for exploration of different ore deposits but most research has been carried out on the base metals, not on the critical and by-product metals. Some of the major structural belts in Iran, especially the Uremia-Dokhtar magmatic belt, the Sanandaj-Sirjan metamorphic zone, the Eastern Iran ophiolitic belt and the Alborz-Azerbaijan structural zone, host various world class ore deposits (e.g., Samani, 1988; Hassanzadeh, 1993; Alavi, 1994; Förster and Jafarzadeh, 1994; Hezarkhani and Williams-Jones, 1998; Shafiei et al. 2009; Shahabpour, 2010; Ghorbani, 2013; Mirnejad et al. 2013; Aghazadeh et al. 2015; Jamali, 2017). There are many potential critical metal resources that have been studied in recent years, including REEs in Bafq district (Daliran and Stosch, 2005; Jami et al. 2007), PGEs in ophiolites (Pazand et al. 2012) and Mo in Iranian porphyry deposits (Shafiei and Shahabpour, 2012).

The purpose of this special issue is to document case studies from current researchers investigating critical and by-product metals in Iran, demonstrating progress in understanding of the geology and geochemistry of critical metal deposits. The main topics include (1) GIS-based geochemical data analysis and interpretation for critical material exploration; (2) Fractal/multifractal and geostatistical modelling of geochemical patterns in 2D and 3D environments; (3) New geochemical exploration method(s) for critical material data analysis, interpretation and exploration; (4) geochemistry of critical material deposits.

Many papers were submitted to this special issue but after a rigorous review process, only four papers were accepted for publication. The first paper, by Afzal et al., discusses geochemical exploration for nickel in the main ophiolitic belts of Iran, based on fractal modeling and factor analysis of stream sediment geochemistry and lithogeochemical data. The second paper, by Yousefi et al., applies multifractal modeling and GIS-based analysis for prospecting of hydrothermal nickel in eastern Iran. The third paper, by Khalajmasoumi et al., investigates prospectivity of REEs in the Saghand area based on lithogeochemical, geological and mineralographical data using fractal modeling. The final paper, by Daneshvar Saein and Afzal, utilises geostatistical and fractal modeling for determination of relationships between faults and Mo mineralization in porphyry deposits of SE Iran.

We would like to thank editors-in-chiefs B. De Vivo and R.A. Ayuso for agreeing to publish these papers in a special issue of the Journal of Geochemical Exploration. Furthermore, we thank journal managers Mr. Aravind Kumar and Ms Shruti Venkiteswaran and special issue manager Emily Chen for assistance in various aspects of this special issue. We are grateful to all the authors for their contributions, even to those whose manuscripts were not accepted to this issue. We appreciate the following reviewers, many of whom reviewed at least one paper, because this special issue could not be published without their time and effort for checking the quality of the papers considered: Frits Agterberg, Emanuel John Carranza, Kathryn Goodenough, Ahad Nazarpour, Naser Madani, Martin Smith, Alaaddin Vural, Gongwen Wang, Amir Bijan Yasrebi, Mahyar Yousefi, Kefa Zhou and Renguang Zuo.