^{50}Ti anomalies in primitive and differentiated meteorites

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We analyzed relative ^{50}Ti abundances in primitive and differentiated meteorites (whole-rock carbonaceous, ordinary, enstatite chondrites, eucrites, angrites, ureilites, SNCs, NWA 2976, Itqiy and silicates of mesosiderites) and terrestrial rock standards, in order to characterise possible correlations with neutron-rich isotopes of Ni and Cr and with O isotopic systematics of early Solar System objects. Chemical purification of Ti from meteorite matrices was achieved on anion exchange resin, with chemical yields in excess of 90% and total procedural blanks < 10 ng Ti. Ti isotopic ratios were determined by MC-ICPMS using the sample-standard bracketing technique, analysing each sample 5-12 times. The accuracy and precision of our analytical protocol were estimated through replicate analyses of terrestrial standards doped with a Ti isotopic tracer, yielding a long-term reproducibility for ^{50}Ti/^{47}Ti of 20 ppm (2sd).

Carbonaceous chondrites are characterised by ^{50}Ti excesses, while ordinary chondrites record deficits. Except for NWA 2976, which shows a ^{50}Ti excess identical to that of CR chondrites, all meteorites originating from differentiated planetesimals record ^{50}Ti deficits. Enstatite chondrites have a terrestrial ^{50}Ti abundance. The range of variation in ^{50}Ti/^{47}Ti between all meteorites studied here spans 0.7‰. We find that ^{50}Ti anomalies correlate with ^{54}Cr and ^{62}Ni variations at the planetary scale [1-2], constraining the existence of two reservoirs in the early Solar System. Further, because neutron-rich isotopes are believed to be formed in old supernova sources rarely associated with young star-forming regions, the well-preserved correlated variations may represent residual heterogeneity inherited from the molecular cloud. In addition, neutron-rich and O isotopes [3] define two mixing trends among CC and OC-D that support two distinct origins for O and Ti isotopic heterogeneities.

References

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Magma genesis and differentiation at Merapi volcano, Sunda arc, Indonesia

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Merapi, a large Quaternary volcanic complex situated within the active volcanic front of the Sunda arc in Central Java, is one of the most active volcanoes in Indonesia. Its recent activity is characterized by the extrusion of high-K basaltic andesite lavas forming lava domes in the summit area and intermittent gravitational or explosive dome failures generating small-volume pyroclastic flows that are a permanent threat to life within the densely populated areas on the flanks of the volcano.

During the Holocene, Merapi erupted basalts and basaltic andesites of medium-K affinity in the earlier stages of activity and high-K compositions from ~1900 years BP to the present. This increase in K_2O is accompanied by a marked increase in whole-rock ^{87}Sr/^{86}Sr ratios, but not by systematic variations in δ^{18}O values, which are relatively constant and slightly elevated compared with mantle values. Whole-rock trace element and isotopic characteristics suggest that mantle source contamination played a significant role in determining the geochemical characteristics of the parental magmas of the two magmatic series. Subsequent differentiation of these magmas during ascent and storage in the arc crust involved a complex interplay of fractional crystallisation, recharge, magma mixing and assimilation of carbonates from the subvolcanic basement. Whole-rock analysis of the crystal-rich Merapi rocks can only provide a blurred picture of these processes and open-system processes, such as crustal contamination, are often masked in the whole rock isotope ratios. Therefore, a more complete picture of these processes has been assembled by combining crystal isotope stratigraphy, petrological analysis of magmatic and crustal xenoliths hosted in recent Merapi deposits and stable isotope analysis of fumarole gases. These studies indicate that magma-crust interaction and late-stage crustal contamination are volumetrically significant and have important implications for magma evolution and, potentially, the eruptive behaviour at this high-risk volcano.