Early degassing of the Earth

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Some of noble gas isotopes are produced by radioactivities having different half-lives: the β-decay of ^{129}I produces ^{129}Xe with $T_{1/2}$ = 15.7 Myr, the spontaneous fission of ^{244}Pu produces $^{131-136}Xe$ with $T_{1/2}$ = 82 Myr, and the still active decay of ^{238}U also produces ^{4}He and $^{131-136}Xe$ by spontaneous fission with $T_{1/2}$ = 4.45 Gyr. Argon-40 is also produced by the β-decay of ^{40}K with $T_{1/2}$ = 1.27 Gyr. These contrasted production rates of noble gas isotopes allow investigation of terrestrial degassing during the accretional period, the Hadean, and from the Archean to present (e.g. [1-9]).

The xenon isotopic composition of the mantle-derived rocks suggests an extended degassing history of the Earth during Hadean, which can be modeled assuming the degassing to be a first-order rate process, i.e. the amount of noble gas extracted from the mantle is proportional to its total amount in the mantle reservoir [9]. In the model, it was assumed that the mangle degassing decreased gradually as expected for a progressively cooling Earth. The efficiency of degassing was estimated to be 1.2×10^{-8} duing Hadean in this model [9], whereas the degassing efficiency of the mantle at present is $0.6\text{-}3.8 \times 10^{-11}$ based on the recent global ^{3}He flux estimate [2]. We investigate how the transition between these two modes of degassing occurred using radiogenic noble gas isotopes.

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Hydrothermal alteration in the Vargeão basaltic impact structure (South Brazil)

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The Vargeão impact structure

Hypervelocity impact phenomena are of primary importance in the evolution of solid bodies of the Solar System[1]. But craters on basaltic rocks, which are the best analogs for the surface of other planets and satellites, are rare on Earth. The 12 km wide Vargeão, which is a well-preserved complex structure formed on basaltic flows of the Serra Geral Formation (about 133-131 Ma) [2]. At Vargeão, the impact-related materials are chiefly represented by centimeter breccia-veins that are found in all lithologies (basalts and ryodacites). We conducted a detailed petrological study (petrography, microprobe, SEM and XRD) on these veins.

Results

Our results show that the veins were strongly affected by the post-impact hydrothermal fluids. The hydrothermal alteration varies geographically in the structure. On the rim area this alteration consists of total or partial substitution of the melt matrix by quartz, calcite and iron oxides. At the central area, the alteration mineral assembly is composed of quartz, iron oxides, zeolites and rarely calcite. Usually, the alteration shows a zoned setting, which also varies locally. At some outcrops on the rim area, we also observed the occurrence of disseminated native copper. Clay minerals (smectites) were observed in all samples and are probably related to weathering. The post-impact hydrothermalism on basaltic craters and their possible implications for the evolution of planetary bodies surface will be discussed.

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