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Hematite spherules formed during combustion of coal waste as an analog of hematite-rich spherules found on Mars

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The question of the origin, manner of crystallization and transportation of the hematite spherules ('blueberries') present on the surface of Mars is still unsolved. Proposed explanations for their origin have suggested: (1) deposition from standing bodies of water, (2) precipitation, oxidation, and crystallization in a hydrothermal environment, (3) growth as concretions in stagnant ground waters, (4) sulfur-bearing water reaction with volcanic ash and basaltic pyroclastic deposits, (5) oxidation of jarosite or other iron sulfide/sulfate minerals, (6) accretionary lapilli due to impact surges (7) hematite coating, (8) production in a thermal system of organic compounds and (9) transportation of spherules now present at Meridiani Planum and Aram Chaos, and possibly at Chryse Planitia, from Valles Marineris in washout flows together with sulfate minerals, pyroclastic and basaltic clasts and their deposition as alluvial or fluvial rocks later open to diagenetic processes.
Fe-oxide hematite ([U+F061]-$Fe2O_3$) covering huge areas of Meridiani Planum on Mars lie mainly on outcropping rock of basaltic composition rich in sulphur and the ferric sulfate hydroxide jarosite. Many hydrated sulfates have been identified in Valles Marineris. They form massive thick layers composed of gypsum CaSO4•$2H_2O$, kieserite MgSO4•$2H_2O$ and polyhydrated sulfates. The size of the hematite spherules is ca 4.2 [U+F0B1] 0.8 mm. They show a minor NiO impurity.
Exhalating hematite is ubiquitous in overburning coal-waste dumps in Silesia, Poland. It is associated with the formation of hematite spherules which in their shape, abundance and inner structure match the hematite spherules photographed by the Rover landing craft on Mars. In the self-ignited and self-heated Marcel dump, hematite formed in association with alunite - KAl3[(SO4)2l(OH)6],) anhydrite - CaSO4, godovikovite - (NH4)Al[SO4]2), iowaite - Mg4Fe (OH)8OCl•4(H_2O), coctaite - (NH4)Ca[SO4]2•H_2O, steklite - K,Al(SO4)2, lesukite - Al2Cl(OH)5•$2H_2O$, millosevichite - Al2[SO4]3, natroalunite - NaAl3[(SO4)2l(OH)6], pyrite - FeS2 and native sulphur. Hematite spherules crystallized during a late hydrothermal phase. Although they are much smaller in size at ca 20-50 micrometres, the duration of the process was likely much shorter than that on Mars. The coal-waste dumps provide a quasi-volcanic setting that is a potential terrestrial analogue for the formation of the larger Martian spherules.