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Transformation of goethite/ferrihydrite to hematite and maghemite under temperate humid conditions in Denmark

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At a number of sandy soil sites in Mid Jutland, Denmark, with iron content of 1-2%, very red spots (Munsell colour: dusky red 10R 3/4) of a few square meters are found. These spots are most likely due to burning events. After the fire ashes raised pH. This dispersed silt and clay size soil particles which were then transported with seepage water down into lower soil horizons. These particles contain hematite and maghemite due to influence of the fire.

However, a long-standing unresolved question is how hematite and maghemite can also be present along with goethite and ferrihydrite, in the same geographical region, and in extended areas with high iron content (8-40 %) in the topsoil. Hematite and particularly maghemite would normally not be expected to form under the temperate humid Danish climate, but be interpreted as the result of high temperature as found in tropical regions or as seen in soils exposed to fire. The high iron content most likely has its origin in pyrite dissolution in top of the groundwater zone in deeper Miocene deposits. From there $Fe2+$ is brought to the surface by the groundwater, and in wells oxidized by meeting the atmosphere and precipitated as two line ferrihydrite. This is later transformed into goethite. However, along with these two minerals hematite and maghemite are present in the topsoil around the well area. Forest fires would be a likely explanation to the hematite and maghemite. But a body of evidence argues against these sites having been exposed to fire. 1) The pH in the topsoil is 3.6 – 4.8 and thus not raised by ashes. 2) No charcoal is present. 3) There is no indication of fire outside the high iron content areas. 4) Goethite is present along with hematite and maghemite in microparticles, and the mineralogical zonation produced in a forest fire is not seen. The natural sites contain a uniform mixture of goethite/ferrihydrite, hematite and maghemite down to 20 cm depth. An experimental forest fire left charcoal and ashes at the topsoil, produced high pH, mineral zonation and decreased organic matter content, all of which is in contrast to the natural sites. In the freshly precipitated iron materials iron oxidizers as Gallionella sp. were found, but also iron reducing Geobachter sp.were present. Microbial activity might have influenced the mineral transformations.

References: Nørnberg, P., Vendelboe, A.L., Gunnlaugsson, H.P., Merrison, J.P., Finster, K., Jensen, S.K. 2009 Mineralogy after an experimental forest fire on Quaternary soil goethite, compared with a hematite, maghemite, goethite containing topsoil. Clay Minerals, 44, 239-247.
Nørnberg, P., Gunnlaugsson, H.P., Merrison, J.P., Vendelboe, A.L. 2009: Salten Skov I: A Martian dust analogue. Planetary and Space Science, 57, 628-631.
Nørnberg, P., Schwertmann, U., Stanjek, C.B., Andersen, T., Gunnlaugsson, H.P. 2004: Mineralogy of Quaternary iron oxide rich formations in Denmark.Clay Minerals, 39, 85-98.