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The mobility of Fe(III) and P in sulfate- and carbonate-rich fluids with implications in the formation of iron oxide-apatite deposits

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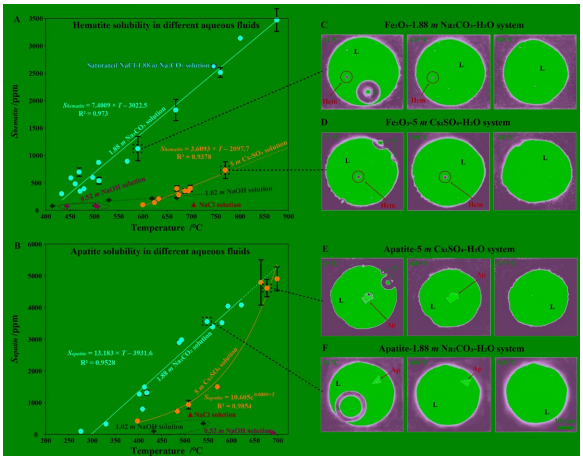

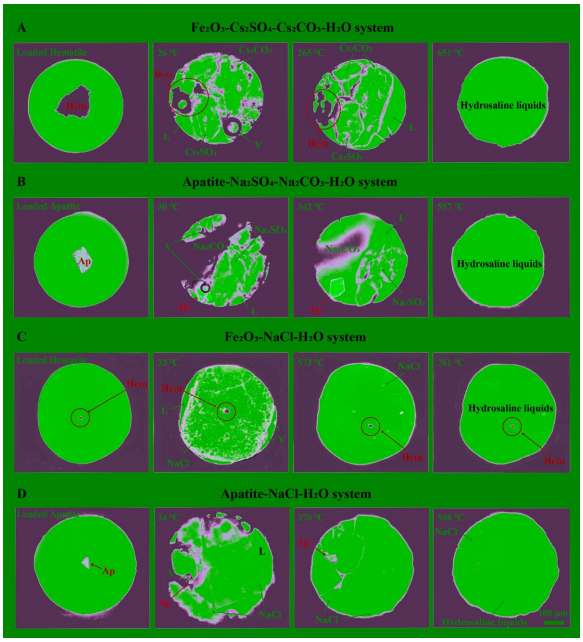

Fe(III)-oxides and phosphates are traditionally considered as insoluble components in geofluids[1-2], but recent studies suggest that sulfate-rich fluids, in some cases with high contents of carbonate solutes, play critical roles in migrating Fe and P in iron oxide-apatite (IOA) deposits. Some of these fluids have extremely high contents (e.g., >90%) of solutes and are known as hydrosaline liquids[3-6]. In this study, we experimentally investigated the solubility of hematite and apatite in sulfate- and carbonate-rich fluids (including hydrosaline liquids) and explored the mechanism of Fe and P migration in IOA systems (Fig. 1 and Fig. 2). It is confirmed that both sulfate- and carbonate-rich fluids can effectively transport Fe(III) and P, and carbonate-rich fluids show greater ability in migrating Fe(III) compared to sulfate-rich fluids. These results indicate that Fe(III) is a mobile component in the sulfate- and carbonate-rich fluids found in IOA deposits, and precludes oxidization of fluid-borne Fe(II) as a necessity for the formation Fe(III)-oxide ores. The critical roles of evaporite and/or carbonate assimilation during emplacement of IOA-related magmas are also highlighted. First, it leads to the formation of sulfate-, and in some cases carbonate-rich, magma and subsequently post-magmatic fluids that can transport both Fe(III) and P. Second, the assimilate of sulfate-rich evaporites drives oxidizing of Fe(II) to Fe(III) in the magmas. The elevated proportions of Fe(III) to total Fe facilitates the formation of Fe ores that comprise Fe(III)-bearing oxides (i.e., hematite and magnetite), rather than economically invaluable Fe(II)-minerals such as pyroxene.

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