



## Evaluating the effects of deformation on the chemistry of composite magnesioferrite-magnetite crystals by means of EBSD

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Chemical signatures of magnetite are commonly used to track the evolution of mineralizing systems in many geological settings. However, the impact of deformation processes on magnetite chemistry remains still underexplored. Here, we report a rare case of composite crystals consisting of magnetite and magnesioferrite recording different degrees and styles of deformation in order to evaluate how deformation promotes chemical modification. The samples employed in this study come from two different Mg-skarn iron deposits (i.e., El Robledal and San Manuel) from the Serranía de Ronda (SW Spain). Chemical data acquired by Electron Probe Microprobe Analyzer (EPMA) and Field Emission Scanning Microscopy (FESEM) are contrasted against microstructural data obtained by using Electron Back-Scattered Diffraction (EBSD). Our results show that magnesioferrite crystals [ $\text{Fe}^{2+}\# (\text{Fe}^{2+}/\text{Fe}^{2+}+\text{Mg}^{2+}) = 0.22-0.46$  and  $\text{Fe}^{3+}\# (\text{Fe}^{3+}/\text{Fe}^{3+}+\text{Al}^{3+}) = 0.99-1.00$ ] from El Robledal deposit are characterized by a ductile deformation that led to different crystallographic orientation domains along with the replacement of magnesioferrite by magnetite [ $\text{Fe}^{2+}\# (\text{Fe}^{2+}/\text{Fe}^{2+}+\text{Mg}^{2+}) = 0.51-0.99$  and  $\text{Fe}^{3+}\# (\text{Fe}^{3+}/\text{Fe}^{3+}+\text{Al}^{3+}) = 0.98-1.00$ ] via coupled dissolution – reprecipitation. A replacement of magnesioferrite [ $\text{Fe}^{2+}\# (\text{Fe}^{2+}/\text{Fe}^{2+}+\text{Mg}^{2+}) = 0.43-0.64$  and  $\text{Fe}^{3+}\# (\text{Fe}^{3+}/\text{Fe}^{3+}+\text{Al}^{3+}) = 0.99-1.00$ ] by magnetite [ $\text{Fe}^{2+}\# (\text{Fe}^{2+}/\text{Fe}^{2+}+\text{Mg}^{2+}) = 0.78-1.00$  and  $\text{Fe}^{3+}\# (\text{Fe}^{3+}/\text{Fe}^{3+}+\text{Al}^{3+}) = 0.98-1.00$ ] via a coupled dissolution – reprecipitation mechanism is also preserved in the composite (i.e., zoned) crystals from the San Manuel deposit, which was additionally overprinted by an additional recrystallization event as a result of grain boundary migration recrystallization. Our results show that deformation in a fluid-assisted deformation regime has induced chemical modification of the original magnesioferrite aggregates as well as strain localization. This close physicochemical link offers new avenues of interpreting the chemical signatures of Mg-Fe oxides, utilizing their microstructurally controlled variation or lack thereof.