Both iron oxides and carbonate minerals, such as calcite, can sorb zinc (Zn), and therefore are important in controlling the solution concentration and availability of Zn to plants growing in calcareous soil. When present together, interactions between these components affect their sorption behaviour. We investigated changes in the reactions of Zn with calcite at alkaline pH, as the calcite surface was progressively coated by iron oxide. Coated calcite surfaces were prepared that had from 0.05 to 1.45% iron oxide. The initial concentration of Zn and the amount of iron oxide on the calcite were the most critical factors affecting adsorption, precipitation of solid phases, and the desorbability of sorbed Zn. For pure calcite at small initial Zn concentrations (<2.5 x 10^{-5} M) adsorption was dominant; with increasing concentration, precipitation of hydrozincite (ZHC) became more important. With increasing amounts of iron oxide the amount of Zn adsorbed increased, the desorbability of the Zn decreased, and precipitation became progressively less evident, and at 1.45% iron oxide content there was no evidence of any precipitation of ZHC. The calculated maximum adsorption attributable to the iron oxide coating was inversely proportional to the thickness of the oxides on the calcite, and greatly exceeded that of iron oxide as a separate phase. The common occurrence of iron-coated carbonates in calcareous soils and their capacity to adsorb Zn contributes to the problems of Zn deficiency, for which these soils are noted.