Efficiency of permanganate for arsenite oxidation

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The maximum contaminant level (MCL) of As in drinking water has been decreased to 10 µg/L in many countries. Conventional water treatment for As removal requires an oxidation process of As(III) to As(V) because the former is more mobile and substantially more toxic than the latter. Potassium permanganate ($KMnO_4$) has been suggested to rapidly and effectively oxidize As(III). The stoichiometric demand for $KMnO_4$ to oxidize As(III) is assumed to be 1.5 because the product of the redox reaction has been considered simply to be MnO_2(s). It has been well known that manganese forms various types of oxides or oxyhydroxides, which are also important oxidants under natural conditions. Their reactivity and oxidizing power generally depend on the valence (IV, III, or mixed valence) of structural Mn and the specific surface area of the solid. This indicates that the stoichiometric ratio of As(III) to MnO_4 may not simply be 1.5 but depend on the type of the reaction product, which has rarely been charaterized. In addition, the efficiency of permangante for As(III) oxidation would likely increase if the reaction product can also oxidize stoichiometirc excess of As(III).

In this study, As(III)-MnO_4 redox reactions were examined under varying conditions to characterize the reaction product and to test the efficiency of permangante for arsenite oxidaiton. Batch experiments were conducted varying doses of As(III) (1 or 10 µM and $KMnO_4$ (0.5 or 5 µM at pH ~ 7 in 10 or 50 mM $NaNO_3$. Permanganate was rapidly consumed for As(III) oxidaiton within 1 min with a reaction stoichiometry of 2.1 ± 0.1. This result imply that the solid-phase reaction product may not simply MnO_2(s) but possibly be Mn(III)-soild phase or Mn(IV/II)-mixed valence phase. Subsequent oxidation of residual As(III) took place more slowly by the reaction product and was completed in a week. In the subsequnt oxidation, As(III) sorption to and oxidation on the reaction product and desorption of As(V) successively occurred, and the sorption was likely the rate-determining step. The final reaction stoichiometry was increased to 2.5 ± 0.1.

Slab melting beneath Central Mexico: A seismological perspective

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Slab melting has been suggested as one of the processes that produce adakites, with typically high Sr/Y ratio and low Y abundance. However, it is difficult to unambiguously distinguish slab melting from other petrological processes such as lower crustal melting based upon geochemical data alone. Furthermore, few, if any geophysical studies have tried to constrain the slab in regions of adakite production. S-to-P (SP) waves that convert locally from the boundary of the oceanic crust and mantle within the subducting slab are particularly useful to constrain its near-source structure and especially the velocity contrast across the crust/mantle boundary. Broadband regional P waveform data from forty moderate intra-slab earthquakes were used to provide detail sampling of the slab structure from the entire Central Mexico subduction zone (104W-96W). The converted SP waves recorded from events to the west (100W-104W) arrive about 2-2.5 seconds after the direct P waves with strong amplitude. To explain these waveforms, we find that it is necessary to include a thin, ultra-slow layer (USL, 3 km; Vs=2.0-2.7 km/s) within the subducting Cocos plate at about 50 km depth. In contrast, the converted SP waves recorded from events to the east (100W-96W) generally arrive about 1 sec after the direct P wave while their wave trains exhibit strong correlations. The USL model is inconsistent with these data, whereas models including a thin, slow layer (SL, 6 km; Vs = 3.8-4.0 km/s) explain these wave trains very well. In the west, the presence of the USL suggests that part of the subducting oceanic crust is likely partially molten whereas to the east, lesser amounts of or perhaps no melting occur within the crust. Seismic detection of the USL in the west is supported by the 12 vs 20 Myr age difference of the subducting Cocos plate between the west (warmer) and east (colder). The seismic interpretation can be examined in the context of the petrogenesis of the volcanic rocks, using the abundance of Nb, Ta and Y and Sr/Y ratio [1-5]. We find that Nb, Ta and Y decrease toward the west while Sr/Y ratio increases. Such strong along-strike variations are difficult to explain by differences in assimilation/fractional crystallization since the Mg# is almost constant across the region. The presence of the USL in the west provides strong seismological evidence for the slab melting that is clear in the geochemistry of the volcanic rocks [1-4].

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