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Arsenic concentrations in groundwaters from two areas in Ghana, the Obuasi area in the Ashanti region and the Bolgatanga area of the Upper East region vary from <1–64 μg 1−1 and <1–141 μg 1−1, respectively. Sulphide minerals such as arsenopyrite and pyrite are present in the Birimian basement rocks of both areas and these form the dominant As sources. The basement aquifer is overlain by a variable thickness (ranging from <10 m to >40 m) of weathered regolith and lateritic soil. Arsenic concentrations are low in the shallowest groundwaters, but increase at greater depths (40–70 m below ground level in Obuasi and 20–40 m in Bolgatanga). At depths greater than this, total As concentrations are relatively low. The lateral and vertical variations in dissolved As concentrations are controlled by ambient pH and redox conditions and by the relative influences of sulphide oxidation and sorption. In the weathered regolith and lateritic soils, oxidation has been extensive. Shallow groundwaters are oxidizing and acidic. Under these conditions, As is readily oxidized to As(V) and may precipitate as ferric arsenate or be sorbed onto ferric hydroxide surfaces. At greater depth, groundwaters have longer contact times with the aquifer minerals and pH values are therefore higher (>6.0 in Obuasi and >6.5 in Bolgatanga). The oxidation of sulphide minerals may proceed, but dissolved O is consumed during the process and mildly reducing conditions (Eh 200–300 mV) result. Sorption of As onto ferric hydroxide minerals is less favoured under such pH and redox conditions and the element is relatively mobile. At the greatest abstraction depths, groundwaters are more reducing (Eh ≤200 mV; dissolved O <0.1 mg 1−1) and few electron acceptors are available in the system to drive sulphide oxidation. Dissolved As concentrations therefore remain relatively low. The mildly reducing groundwaters in the sulphide-bearing basement aquifer are therefore of the poorest potable quality with respect to dissolved As concentrations.