Predicting areas of groundwater As contamination from surface parameters and geology at depth

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Arsenic (As) contamination of groundwater resources threatens the health of millions of people worldwide, particularly in the densely populated river deltas of Southeast Asia. Although many As-affected areas have been identified in recent years, a systematic evaluation of vulnerable areas remains to be carried out. In order to pinpoint untested areas at risk of groundwater As concentrations, we produced a risk map by combining geological and surface soil parameters in a logistic regression model, calibrated with 1756 aggregated and geo-referenced groundwater data points from the Bengal, Red River and Mekong deltas [1].

We show that Holocene deltaic and organic-rich surface sediments are key indicators for arsenic risk areas and that the combination of surface parameters is a successful approach to predict groundwater As contamination [2]. Predictions are in good spatial agreement with known areas of groundwater As contamination but also indicate elevated risks in Sumatra and Myanmar where no groundwater data existed [3].

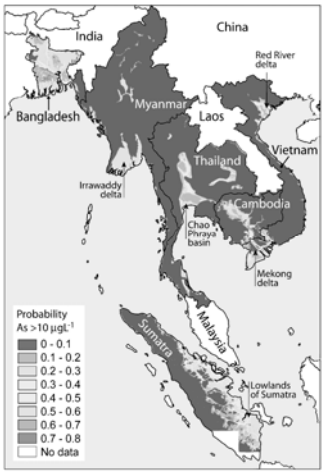

Figure 1. Probability map of As levels exceeding 10 µg/L (WHO guideline) in Southeast Asia and Bangladesh [1].

All the above is based on two-dimensional data (that is, surface maps). We are currently exploring avenues of three-dimensional predictions for the Red River delta (Vietnam). Results of this approach will be presented and compared with the predictions modeled entirely from surface parameters.

[1] Winkel *et al.* (2008) *Nature Geosci.* **1**, 536-542. [2] Amini *et al.* (2008) *Eviron. Sci. Technol.* **42**, 3669-3675. [3] Winkel *et al.* (2008), *Appl. Geochem.* **23**, 3019-3028.

Experimental constraints on igneous crustal stratigraphy in Martian volcanic provinces

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Several crustal structure models generated from Mars Global Surveyor (MGS) topography and gravity data have revealed that the major shield volcanoes are coupled with significant gravity anomalies [1, 2]. In order to best fit crustal structure models, [1, 3] assigned a greater density to the shield volcanoes than to the surrounding crust. However, the paucity of compositional data and petrologic knowledge of the shield volcanoes makes it difficult to assess the validity of this density assignment. We are experimentally investigating the effects of pressure on fractionation of mantle-derived magmas at the base of the primary crust. These experiments will provide insight into the compositional variations that could have arisen as the secondary crust progressively thickened over time.

The phase equilibrium experiments conducted by [4] on a 'dry' Humphrey composition at 9.3 kbar (~70 km depth) were supplemented with experiments at 16 kbar (~120 km) and hydrous experiments at 5 kbar (~35 km). The experimental data indicate that low-density silica-rich, Fe-depleted lavas would be overlain by more dense Fe-rich, alumina- and silica-depleted lavas. These lavas in turn would be overlain by more aluminum-rich, alkali-rich, and Ca-poor *ne*-normative lavas that retained low silica and high Fe characteristics. The cumulus layers would evolve from early olivine- and pigeonite- dominated assemblages to olivine free pyroxene assemblages.

The observed pressure-induced compositional variations imply that crustal density heterogeneities could exist within Martian volcanic provinces. Future crustal structure models will need to take these results into consideration.

[1] Neumann *et al.* (2004) *JGR* **109**, E08002. [2] Kiefer (2004) *EPSL* **222**, 349-361. [3] McGovern *et al.* (2004) *JGR* **109**, E07007. [4] McCubbin *et al.* (2008) *JGR* **113,** E11013.