Total Mercury and Methylmercury Accumulation in Aquatic Sediments

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Methylation of Hg in sediments is a crucial process that controls Hg accumulation in biota. Several studies have reported a significant positive correlation between methylmercury (MeHg) and total Hg in aquatic sediments. However, these relationships differ among studied systems due to geochemical and biological controls. We show here, by compilling published and unpublished HgT-MeHg couples from riverine, estuarine and marine sediments covering various environmental conditions, from deep pristine abyssal to heavily contaminated river sediments, that a general relationship relies the two parameters. The net methylation, i.e. methylation/demethylation equilibrium, governs the position of the points within the drawing. This global equation suggests that most of the variability in the MeHg concentration is explained by the inorganic Hg availability, a proxy of which is HgT in the sediment. The position of the points on both sides of the equation line are discussed in terms of redox and sedimentation conditions, with surface sediment points above the line.

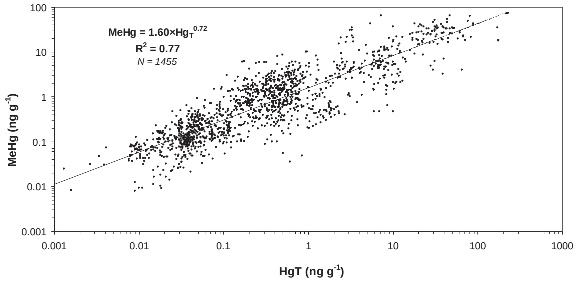

Figure 1: The unpublished results are from abyssal plains of the Arctic Ocean and the Mediterranean Sea, and continental shelf and bays of the Mediterranean Sea. Published results are from references 1 to 15.

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Time scales of magmatic processes and volcanic unrest at caldera systems

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Calderas are capable of producing the largest and most explosive eruptions on Earth. The type of unrest in many caldera systems consists of long periods (years or decades) of deformation and earthquake activity (e.g. Campi Flegrei - Italy, Yellowstone or Long Valley – USA); however not all periods of unrest culminate in a volcanic eruption and not all eruptions are related to a caldera collapse. Despite the importance of properly interpreting the caldera unrest signals as magmatic proceses, there are few historical caldera eruptions that have been well monitored. We have taken a complementary approach to understanding the dynamics of magmatic processes at calderas by studying crystal zoning styles from the Minoan eruption of Santorini. Modeling the zoning patterns of the crystals can provide the times involved in destabilization of the magmatic system, and allows first order comparisons with the time scales of unrest signals. We investigated more than 300 plagioclase crystals with the electron microscope. A subset of these were investigated with the electron microprobe, and from these the trace element zoning of six crystals were measured by SIMS.

We distinguished two main types of plagioclase; a dominant one with cores at about An_{43-58} and another, very rare, type with cores at An_{30-36}. Both types have similar rims at about An_{36-43}, and also rare high An cores (58-88). We think that these crystals record at least two mixing events. A first involved a basaltic-andesitic magma with an dacitic one at relatively deep levels, and later on these two magmas mixed with a rhyolitic magma located much closer to the surface. We have modeled the Mg and Sr zoning profiles across the different zones of the crystals using a diffusion model. We find two time scales associated with the different mixing events. A few decades occurred since the first and deeper mixing event and eruption, whereas the last transfer of the mixed dacite into the shallow rhyolite only occurred a few months prior to eruption. Mass balance constraints indicate that the dacitic magma that intruded in the upper reservoir accounted for at least 15 % of the total hybrid magma erupted, or about 5-9 km^3 of replenishment. The two time scales we have found are analogous with the three decades of deformation and seismic unrest that occurred at Rabaul caldera during 1973-1994, and which culminated in eruption in 1994 after an increased seismicity and deformation only about 5 months before eruption.