Differentiating fluid boiling from condensation

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Fluid inclusion petrography cannot differentiate boiling from condensation. Inclusions formed during boiling and condensation may have liquid- and vapour-dominant types that show approximately the same Th. During boiling a vapour phase develops in response to changes in liquid P or T. Condensation occurs when a liquid is subject to a vapour flux. This may occur at any depth in geothermal systems. At shallow depths this process generates steam-heated waters. At greater depths vapour from magmatic bodies can flux through circulating meteor waters.

Modelling demonstrates that boiling and condensation changes the concentrations of gaseous species in different manors. Boiling strips dissolved gaseous species from liquids and low solubility species such as H_2, CH_4 and N_2 more strongly partition into the vapour phase. Hence a ratio of soluble species like CO_2 to N_2 increases during boiling. Condensation increases liquid concentration of soluble gaseous species (see fig.). Gas ratios from the USGS Cerro Prieto data set show positive correlations between total gas and CO_2/N_2 ratios. Sequential fluid inclusion gas analyses shows negative correlations at Guanajuato where there is other evidence of boiling and positive correlations in geothermal systems were condensation is predicted.

We know that gaseous components and liquids commonly decouple and recombine in geothermal systems. We find evidence in active geothermal systems and in fluid inclusions that both processes operate. Condensation may be an import process in the production and localization of high grade sulphide ore bodies by locally producing high fluid concentrations of H_2S.

Quantifying accelerated surface denudation as a result of external forcing

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The evolution of mountain belts is a balance between forces that build topography and those that destroy topography. This study focuses on the destructive forces, weathering and mass wasting, fluvial or eolian erosion, glaciers, etc., that are inherently surfacial processes. In order to understand how orogens change through time, we need to identify and quantify the processes responsible for denudation.

We apply a combination of novel and proven techniques to address the question of how these forces modify the landsurface. Morphometric analysis based on high resolution LIDAR data is used to identify transient landscapes. These geomorphic data are then combined with cosmogenic nuclides, ^{10}Be from quartz in sediment specifically, in order to quantify process rates.

In a case study in the Alpine Foreland, we identified two adjacent drainage basins which have responded differently to the same forcing event, a fall in stream base-level at 16,000±3,000 yrs BP. One of the watersheds has a coupled hillslope-channel system, while the other is decoupled. Denudation rates in the coupled system, 380±50 mm ky^{-1}, are equal to those in the headwaters of the decoupled system, 380±50 mm ky^{-1}. However denudation rates in the decoupled system increase downstream to 540±100 mm ky^{-1}, with denudation in the incised region occurring at extremely high rates, ~1800 mm ky^{-1}. The denudation rates show that within 16,000 yrs, only the channels themselves have responded, and spatially extensive erosion occurs only after a significantly longer lag time.

The advantage of this approach is that the geomorphic response of a landscape to external forces can be identified by morphometric analysis, and the process rates that are measured with cosmogenic nuclides can be used to quantify landscape response times on the time scale of climate change or fault movement.