Extra-thick plates: Basis for a single model of mantle magmagenesis, all the way from MORB to kimberlite

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Tectonic evidence [1, 2], briefly outlined, that cratons have tectospheric keels that approach 660km, demands an appraisal of how this radical change reflects upon the genesis and significance of mantle-derived magmas, noting that this perspective extends (less deeply) all the way to MORs [2]. We show that without calling on extraneous heat sources magma-genesis by thick-plate splitting yields many rewarding insights.

The basic model [3] envisaged a split-induced diapir in a deep, narrow, mantle crack, and needed thick plates to be fully applicable. We present four simple variants of this model, adapted to each of MORB, OIB, CFB and kimberlite. Source compositions are still important but processing is central and (variably) thick plates provide the column-space to do it in, with a varying result. Among the notable features are:-

(a) Melting in the diapir decreases again as wall cooling asserts control. Enlarged by cumulate intergrowths, the solids form a 'log-jam' in the crack (familiar to engineers), and melt is forced through it (primary segregation). So this depth varies with current parameters (wall temperature, splitting rate), the jam providing xenoliths when ruptured. The force to do so and ability to extract melt increases with jam depth (kimberlite).

(b) Reduced pressure at the foot of the diapir causes incipient melting of mantle accessories, trace element contents being drawn, and gases diffuse, along melt pathways, resulting in light-isotope enhancement (OIB). MOR continuity promotes self-cancelling of this effect, so a common source is possible.

(c) Heated by an eruption, the big volume increase at the gt-sp peridotite phase change in the walls may close the crack, prising it apart elsewhere. In our MOR variant this is the push-apart force. In the IOB case, it may prolong volcanic chains.

(d) In the MOR variant, crystal accretion to narrow-crack walls uniquely explains the straightness, segmentation and seismic anisotropy [4], strongly supporting our basic model.

[1] Osmaston (2006) *Proc. ICAM IV,* OCS Study MMS 2006-003, p.105-124. Also at, http,//www.mms.gov/alaska/icam. [2] Osmaston (2007) *XXIV IUGG*, IASPEI JSS 011 Abstr. #2105. http,//www.iugg2007perugia.it/webbook/
[3] Osmaston (2005). *GCA* **69**, (10S) A439. [4] Osmaston (1995) *XXI IUGG,* Boulder, Colorado, Abstracts p. A472. (*N.B.'c-axes' should read 'a-axes'*)

Oxygen mass transfer from trapped gas phase and its biogeochemical consumption

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Contaminated aquifers are often depleted by the biogeochemical consumption of oxygen, and the attenuation of contaminants could be enhanced by additional supply of oxygen. Gas sparging is a remediation technique that supplies addional oxygen to ground water via injection of air or oxygen gas. For the performance of this method the mass transfer of gases from the gas phase trapped after injection is a key process, similar to the processes occurring for trapped air at the capillary fringe. Our study investigated gas sparging in this respect experimentally as well as numerically. We extended an existing numerical model called KBD [1], which describes the mass transfer processes and gas phase development after injection in a kinetic framework. A series of laboratory columns experiments with sandy aquifer material included use of SF_6 as a partitioning tracer, measurement of breakthrough curves of dissolved gases and dissolved tracers for a number of oxygen gas pulses. Further experiments established a chemical oxygen consuming reaction and proved that the degradation reaction, which depends on the transfer of oxygen into the aqueous phase, itself influences the fate of the gas phase noticeably.

Oxygen transfer into the aqueous phase is slowing down with number of gas pulses and strongly depends on the reverse transfer and accumulation of nitrogen. The composition of the entrapped gas phase, the volumetric changes of the entrapped gas phase and the transport of oxygen through the columns could be reproduced. An analysis extending to a field situation included a range of biological degradation rates and studied injection of pure oxygen versus air. The results give evidence that partitioning tracers and the naturally occurring nitrogen can contribute additional information on the gas dissolution process and thus the transfer of oxygen and the stimulation of biodegradation.

[1] Holocher *et al.* (2003) *Environmental Science & Technology* **37**(7), 1337-1343.