Structural control on magmatism along divergent and convergent plate boundaries

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Plate boundaries, characterized by seismic and volcanic activity, are the most active, unstable and hazardous areas on Earth. Our knowledge on the structure and magmatic processes along plate boundaries has dramatically improved in the last decade, allowing proposing a timely overview on the structural control on magmatism.

I first provide an overview of the main structural features along divergent and convergent plate boundaries, as well as their relationships to volcanism. Such an overview is meant to summarize the current state of the art, offering a comprehensive perspective, highlighting tectono-magmatic relationships, similarities and differences in the various settings.

I then propose an original and innovative frame to understand and study tectono-magmatic processes along plate boundaries, based on the two following major points. a) Tectonics and magmatism are both effective in controlling the development of any plate boundary. Along divergent plate boundaries, regional tectonic extension may play a major role in the early phases of rifting, at least in the upper crust; however, magmatism is the most effective way to spread plate boundaries apart along mature continental rifts and oceanic rifts. Along convergent plate boundaries, at least three different processes may allow magma to play a crucial role in controlling the structure of volcanic arcs. This suggests that a significant part of the evolution of both divergent and convergent plate boundaries is magma-induced. b) Magmatism along both divergent and convergent plate boundaries focuses along wedges, or magmatic systems, usually controlled by a dominant volcano. Magmatic systems display specific geometric features, suggesting that the linear mode of magmatic accretion of divergent plate boundaries and extensional arcs is replaced by a punctiform mode of accretion in compressive arcs. Also, magmatic systems in each tectonic setting are characterized by specific compositional features, as a function of the opening rate: these compositions range from mafic (fast oceanic ridges), passing to bimodal, with a progressively higher amount of felsic component (from slow spreading ridges to immature continental rifts), to reach andesitic terms (compressive arcs).

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