DIKE EMPLACEMENT IN FRACTURED MEDIA: A BOUNDARY ELEMENT MODEL

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Volcanic edifices are often characterized by intense fracturing. The generation of these cracks is caused by several factors related to volcanic activity, like degassing, chemical action of hydrothermal fluids and stress corrosion, whereas fracturing is also a consequence of the intense stress produced by repetitive magma injections. Intrusion processes are accompanied by seismic swarms, documenting the genesis of shear processes that develop diffusely around the intrusion. The rock resistance sinks with increasing fracture density, and it is important to quantify the effects of this weakening on the dike itself.

At this purpose a boundary element approach is used to model dike intrusions in cracked media. The dike is modeled as a pressurized opening crack, and many fractures are randomly distributed around it and are free to open or shear under the stress field produced by the dike. In other words, normal and tangential stress on the dike and fractures surfaces represent the boundary conditions of the problem and normal and tangential displacement represent the unknowns. We quantify how the intrusion width and the stress intensity factor increase with increasing crack density. This is leading to a complex cause-effect interaction: (1) a dike intrudes in a medium, (2) fracturing is produced and fracture density increases while decreasing the elastic strength of the rocks, (3) the width of the dike and the intensity of the stress field increase, (4) new fracturing is generated, returning to point (2) and starting a cyclical process. A self-accelerating mechanism may thus be possible and lead to eruptions if the stress intensity factor reaches the critical value represented by the fracture toughness. Analytic relations deduced from effective media theories have been found to good approximate the results, particularly for minor values of the crack density. Data collected during injection events seems to confirm theoretical and numerical findings.