Multiphase Modeling of Contact Metamorphic Systems and Application to a Miocene Transitional Geomagnetic Field Record, Paiute Ridge, Nevada

J W Geissman (Department of Earth and Planetary Sciences, University of New Mexico, Albuquerque, NM 87131-1116; ph. 505-277-3433; fax 505-277-8843; e-mail: jgeiss@unm.edu); G N Keating (Environmental Dynamics and Spatial Analysis, EES-10, Los Alamos National Laboratory, Los Alamos, NM 87545; ph. 505-667-5902; fax 505-667-1628; e-mail: gkea@lanl.gov)

We present a numerical model that improves our capability to simulate multiphase, nonisothermal flow in variably saturated porous and fractured media, in this case poorly welded to partially fused ash flow tuff, at magmatic temperatures and shallow crustal pressures to better understand the cooling and hence magnetization acquisition history of these rocks. Simulations of heat and fluid flow in variably saturated host rock near a magmatic intrusion provide insight into processes of dryout, condensation, and resaturation effects and implications for host-rock alteration and the rate at which the host rock cools, and thus magnetizations are recorded in it, following contact metamorphism.We developed a numerical model capable of simulating multiphase flow of heat, water and air in variably saturated porous / fractured media near a magmatic intrusion. The numerical code solves nonlinear conservation equations for mass and energy, using thermodynamic properties of water and air in the ranges 101C , T , 1500 C, 0.00123 , P , 1000 MPa and 101C , T , 15001C, 0.00123 , P , 22 MPa, respectively. The study area is located at Paiute Ridge, eastern Nevada Test Site, Nevada, USA, where hypabyssal mafic intrusions were emplaced at about 8.5 to 8.6 Ma (Ar/Ar age estimate) and cooled during a geomagnetic field reversal, inferred from paleomagnetic data from over 100 sites in intrusions and remagnetized host ash-flow tuffs. A radial model of heat flow and multiphase pore fluid flow adjacent to a 12001C intrusion characterizes the thermal evolution of the contact metamorphic system. For likely initial pore saturations of 0.4 to 0.6, Aan expanding dryout zone near the intrusion and a condensation zone of enhanced saturation (S < 0.8) extends 150 to 400 m from the intrusion. Pore water in the condensation zone drains steadily so that host-rock pore saturation never exceeds 0.8. Host rock temperatures reach 8001C near the contact and cool below 1001C within 1000 to 2000 years after emplacement for moderate initial pore saturations (0.4 to 0.6), 2 to 4 times faster than predicted by a

1. Chapman Conference on Timescales of the Geomagnetic Field 2. Poster 3. (a) J W Geissman Department of Earth and Planetary Sciences University of New Mexico Albuquerque NM 87131-1116 (b) 505-277-3433 (c) 505-277-8843 (d) jgeiss@unm.edu 4. No

simple conduction model. The thermal history of the system is very sensitive to initial saturation. The multiphase thermal model allows bounds to be placed on the rate of change of the transitional part of the geomagnetic field during the field reversal recorded at Paiute Ridge. hypothesize

Magnetization acquisition is interpreted to have taken place during the life of the thermal system that developed in the intrusions and contact rocks and that the paleomagnetic data provide a quasi-continuous record of the transitional part of the reversal. Sites in intrusions and thermally annealed ash-flow tuffs reveal subtle yet systematic variations in paleomagnetic directions. We combine the directional data with robust thermal (temperature/time) models to estimate the rate of change of the geomagnetic field. At site 98_42, intensely fused tuff below the sub-vertical contact of the main lopolith of the complex reveals a systematic change in direction of at least 161 from less than a meter from the contact to over two meters away. At site 94_43, moderately fused tuff of the upper country rock to this same lopolith reveals a progressive change in direction from about 220 /+17 to about 270 /+10 between about 440 and 5801C, respectively, in thermal demagnetization. Modeled times of between 140 and 290 years (site 98_42) and between 215 and 440 years (site 94_43) for the duration of magnetization acquisition at two different sites correspond to estimated rates of change of 0.13 to 0.06 degrees/year for the field during the transitional part of the reversal recorded at Paiute Ridge.

Application to a Miocene Transitional Geomagnetic Field

du Globe de Paris, France) ; V. Pavlov (Dept. of Geomagnetism

review the available data and examine possible sources for the weak Hawaiian secular variation, including whether it can be explained entirely by magnetic changes outside the "Pacific" sector of the core-mantle boundary.