2004 AGU Fall Meeting, San Francisco, 13–17 December 2004

Dramatical Impact Of Low Amounts of Swelling Clays On The Rheology Of Alpine Debris Flows

Bardou, E, QUANTERRA, ch. de la Tour grise, 28 / www.quanterra.org, Lausanne, 1007, eric.bardou@bluewin.ch
Bowen, P, AF: Powder Laboratory, Dept. of Material Sciences EPFL, Lausanne, 1015 Switzerland, EM: paul.bowen@epfl.ch
Banfill, P G, School of the Built Environment, Heriot-Watt University, Edinburgh, EH14 4AS United Kingdom, EM: P.F.G.Banfill@hw.ac.uk
Boivin, P., Environmental Geochemistry Group, Laboratoire de Geophysique Interne et Tectonophysique, UMR 5559 (CNRS, IRD, UJF) - Maison des Geosciences, Universite J. Fourier, B.P. 53, Grenoble Cedex 9, 38041 France Pascal.Boivin@obs.ujf-grenoble.fr

Field observations show that the role and amount of swelling clays in the complex hard suspensions of alpine debris flow type were underestimated (see Boivin et al., this session). This work aims at exploring to which extent the swelling clay content influences the global rheology of a flow of rock grains from which the size spectrum extends from clays to gravel. We made a sample from calibrated materials with a grain size distribution similar to that of a viscoplastic debris flow (Bardou et al., 2003). Four replicates were made with the same grading curve. The clay content of the samples was 2% dry weight only, and different 2:1 swelling clay to 1:1 clay ratio were used. The swelling clay ratio (SCR) was calculated as the percentage of 2:1 clay in the clay fraction of the bulk samples. The 1:1 clay was (industrial) kaolinite and the 2:1 clay was a natural soil smectite. The smectite content in the bulk sample ranged from 0% to 2% dry weight, corresponding to SCR ranging from 0 to 80%. The four prepared samples were sheared in the large-size apparatus fully described in Tattersall and Banfill (1983). This apparatus is based on the measure of the torque necessary to rotate an impeller immersed in the sample. The impeller has the form of an "H" and moves in a plane according to two parallel axes. The observed behaviour were very contrasted. The sample with SCR=0 was poorly sensitive to changes in the solid concentration, in contrast to the three samples with SCR$>$0. Moreover, a small change in the SCR of the clay fraction induced a dramatic change of the behaviour of the mixture. For SCR=0, only little changes in the rheological parameters of the bulk samples were observed with respect to changes in the solid concentration. On the contrary the rheological parameters of the bulk samples with SCR$>$0, apparently followed a power law according to solid concentration. These tests carried out in the laboratory accord with observations realised on natural debris flow material. Although these results can't be upscaled to a quantitative assessment of the effects of changes in the SCR in a dense granular suspension they have, however, has a direct implications for debris flow rheological studies. Even though weighting for a very little part of the materials, the swelling clays cannot be neglected in the analysis of such mixtures. Moreover, colloid properties of these clays are very sensitive to factors such as electrolyte composition, clay surface coatings and shaking energy. Therefore, the electrolyte used in test the materials, and chemical equilibration time within electrolyte and solid phase, should be carefully selected with respect to field conditions.

References

Bardou, E., Ancey, C., Bonnard, C. and Vulliet, L., 2003. A typological approach of debris flow useful for hazard assessement in the alpine area. In: D. Rickenmann and C. Cheng-lung (Editors), 3rd DFHM, Davos.

Bardou, E., Bowen, P., Boivin, P., Banfill, P.F.G. submitted Effect of the Clay Type on the Rheology of an Heterogeneous Dense Granular Material. Implication for the Study of Alpine Debris Flow.

Boivin, P., Bardou E., Pfeifer, H.-R.: Role And Behaviour Of Clay Minerals In Alpine Debris Flows. This session Tattersall, G.H. & Banfill, P.F.G. 1983: The rheology of fresh concrete. Pitman, London.