Geophysical Research Abstracts
Vol. 13, EGU2011-4097, 2011
EGU General Assembly 2011

Hydrogeochemical modelling of clay-rich landslides and anomalies in groundwater compositions: evidences from case studies in the northern Apennines of Italy and South Alps of French

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Changes in soil water content, water flows and consequent rise in pore water pressure, are wellknown factors of hillslope instability. Sub surface flow conditions are considered as the main triggering factor for initiation and reactivation of landslides and rainfall is generally assumed as the only water source for groundwater recharge in shallow hillslope aquifers. In some cases, as in highly tectonized areas, faults can affect the groundwater circulation path controlling the rising of deep fluids to the ground surface. Normally, deep fluids have a chemical composition completely different from the shallow groundwater depending on the travel depth, temperature and pressure conditions, mineral composition of the rocks crossed and time of interaction.
In this last case, the deep water inflow at the slip surface may at least locally influence long-term pore-pressure fluctuations, playing a role on slope stability.
In several landslides located in northern Apennines of Italy (Ca Lita, Vedriano) and South Alps of French (Draix, Super-Sauze) the presence of deep fluids has been detected using hydrochemical investigations.
The groundwater was sampled during several field campaigns uniformly spread out over the year from a network of boreholes. Physical and chemical analyses comprised determination of temperature, conductibility, pH, main cations and anions (K+, Na+, Cl-, Ca2+, Mg2+, SO42- and HCO-) while isotopic analysis (Oxygen, Deuterium, Strontium) are still ongoing.
Water chemistry and geochemical/mineralogical analyses of the soil material have been used inside a geochemical program (Phreeqc version 2.17) to check how suitable was observed water chemistry with the reservoir characteristics.
The model simulates the rock alteration by the dissolution of the primary minerals and the precipitation of new phases. Initial parameters were obtained from geochemical and mineralogical analyses or from the literature (kinetics constants). The simulations showed that for some elements (pH, sulphate and calcium), concentrations we found in groundwater could be reproduced.
However, the observed high concentrations in sodium and magnesium were not correctly simulated.
Furthermore, a particular anomaly in the Na+ concentration was observed in the most active part of the landslides.
These results, which will be compared with the isotope analysis, led us to conclude that groundwater was locally recharged with saline waters from areas outside the watershed, coming up through the bedrock using major discontinuities.