XIV CONGRESO GEOLÓGICO CHILENO
LA SERENA | OCTUBRE 2015

Modelling clasts exhumation, transport and weathering during landscape evolution

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Abstract. Grain properties (detrial zircons, comsogenic nuclide concentration, gold particles in placers, weathering grade, specific mineralogy, heavy metals. Etc) are used to identify sources of sediment deposits. Nevertheless, there is no quantitative model allowing grain distribution on the field to be linked with sources taking into account the landscape evolution. Here, we propose an algorithm coupling grains and erosion-sediment fluxes over a changing landscape which is a first step towards such a numerical tool.

Keywords: XIV, Congreso, Geológico, Chileno

1 Introduction -

The provenance of a sedimentary deposits is classically tackled by analyzing the property of detrital mineral grains or gravels: zircons, weathering stage, heavy metals, Cu anomalies, etc. For example, one want to know the provenance of gravels eroded from a supergene enriched Cu source, and spread as exotic deposit (e.g. Sillitoe 2005). The scattering or concentration of such a clast population depends on the landscape evolution over periods lasting 100 kyrs to Myrs. Here we propose a numerical model coupling landscape evolution and clast weathering and transport over such time scales, which is a step towards linking grains gathered on the field, landscape evolution, and provenance.

2 Method, Samples, Results

The landscape evolution model is Cidre (e.g. Carretier et al., 2014). It solves water and mass balances over a regular grid by specifying physically-based deposition-erosion laws (fluxes) depending on slope, lithology and water discharge. We added spherical clasts of any size and mineralogy which are exhumed, transported and deposited according to simple probability rules determined by the local erosion-deposition fluxes at every time step. These clasts can weather in soils and deposits, loosing material and decreasing in size. Their initial lithology makes them traceable from source to sink. We can study their scattering, weathering grade and dispersion during topographical adjustment to uplift or climate change over geological periods. As a proof of concept we have verified that the grain movement is consistent with the erosion-sediment laws in simple situations of a dipping plan corresponding to hillslopes portion, and we show here a theoretical example of the spreading of gravels eroded from two distinct pluton sources during the uplift of a mountain block (Figure 1).

3 Discussion and Comments on the Expanded Abstract

This approach opens different perspectives, from the better understanding of complex couplings between soil weathering and mountain erosion in 3D, an issue linked to climate change over long geological periods (e.g. Anderson et al. 2012), to the prediction of source localization of supergene deposits or placers of heavy metals like gold. A next step is the application and test of this model in documented situations in northern Chile.

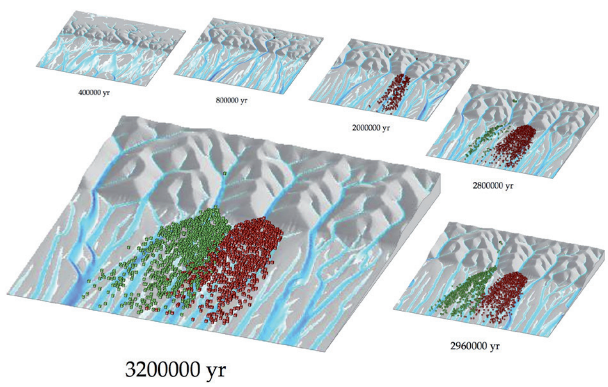

Figure 1. Example of gravels eroded, weathered and transported from two pluton exhuming during the uplift (1 mm/yr) of a mountain block, as predicted by Cidre. Rainfall is

uniform and corresponds to a wet period (1 m/yr). The initial nearly flat topography is uplifted in the north sector. Rivers (blue) develop and auto-organize themselves in the mountain and in the foreland. Two plutons (the green one is 500 m deeper than the red one) exhume progressively and gravels are eroded, transported and finally deposited in the alluvial aprone. These gravels may be as well detrital zircons, gold particles or gravels from a supergene enriched deposit within a porphyry copper. In this case the tectonic and climatic conditions as well as the landscape evolution stage determines a characteristic downstream distance including most of the grains population.

Acknowledgements

This is a contribution to LMI Copedim (http://www2.obs-mip.fr/lmicopedim)

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