Geophysical Research Abstracts,
Vol. 11, EGU2009-1228, 2009
EGU General Assembly 2009

Can a novel combination of organic chemical analysis and inverse modeling help reconstruct the past upper forest line in the Ecuadorian Andes?

B. Jansen (1), E.E. Van Loon (2), and K.G.J. Nierop (3)

(1) University of Amsterdam, IBED-ESPM, Amsterdam, The Netherlands (B.Jansen@uva.nl), (2) University of Amsterdam, IBED-CGE, Amsterdam, The Netherlands (E.E.vanLoon@uva.nl), (3) Utrecht University, Earth Sciences - Organic Geochemistry, Utrecht, The Netherlands (k.g.j.nierop@geo.uu.nl)

The higher parts of the Ecuadorian Andes consist of fragile ecosystems characterized by páramo grasslands and montane cloud forests. Natural climatic change and human interference (i.a. burning and clear-cutting) are believed to have dramatically lowered the UFL in the area to the point that its natural position in the absence of disturbance is now uncertain. This is impeding our understanding of the response of the UFL to global climate change and hindering a correct strategy to reforest areas in the frame of Kyoto Protocol driven activities to fix carbon dioxide. An important cause of the uncertainty is that the traditional method of pollen analysis from peat or sediment deposits alone does not suffice to reconstruct shifts in the UFL. Reasons are the spatial uncertainty caused by wind-blown dispersal of pollen and the limited availability of peat or sediment deposits at all altitudes of interest. The RUFLE* program tackles this problem by combining traditional pollen and vegetation analyses with a novel biomarker approach. In the latter, plant species typical for specific vegetation zones are examined for the presence of biomarkers, defined as plant-specific (combinations of) organic chemical components. Our results show that the leaves and roots of the higher plants responsible for the dominant biomass input in our study area in the Eastern Cordillera in the Northern Ecuadorian Andes contain unique combinations of n-alkanes and n-alcohols in the carbon number range of C20-C36(1). Furthermore, we found these compounds to be well preserved in peat deposits and soils in chronological order for extended time periods (>6000 14C years B.P.)(2,3). As such they offer great potential to serve as biomarkers for past vegetation dynamics, including UFL shifts. However, since it are unique combinations of otherwise ubiquitous n-alkanes, n-alcohols of various carbon chain-lengths that constitute our biomarkers, unraveling the mixed signal of various plants accumulated in soils and peat sediment over time poses a major challenge. To tackle this problem, we developed the VERHIB model that describes the accumulation of biomarkers in soils and peat sediments(4). By inversion the most likely vegetation composition leading to the mixed biomarker signal in the soil or peat sediment in question can be derived. Here we describe the results of the first application of the model in a peat core and several soil monoliths at various altitudes from our study area. Our results show that biomarker analysis using the VERHIB model can indeed serve as a new proxy to reconstruct historic vegetation compositions including the UFL in the Ecuadorian Andes, yielding information that is highly complementary to that which can be obtained through traditional pollen analysis. This is a significant breakthrough from a paleo-ecological point of view as it means an additional proxy is available to be used in combination with traditional pollen- and vegetation analysis. In addition, it is a very promising result from an applied point of view as the information gained will aid the Ecuadorian government in its strategic decisions concerning reforestation of possibly degraded natural areas.

1)Jansen, B. Nierop, K.G.J., Hageman, J.A., Cleef, A.M. & Verstraten, J.M. 2006. The straight chain lipid biomarker composition of plant species responsible for the dominant biomass production along two altitudinal transects in the Ecuadorian Andes. Organic Geochemistry 37: 1514-1536.

2)Jansen, B. & Nierop, K.G.J. 2008. Methyl ketones in high altitude Ecuadorian Andosols confirm excellent conservation of plant-specific n-alkane patterns. Organic Geochemistry (in press).

3)Tonneijck, F.H. & Jongmans, A.G. 2008. The influence of bioturbation on the vertical distribution of soil organic matter in volcanic ash soils: a case study in Northern Ecuador. European Journal of Soil Science 59: 1063-1075.

4)Jansen, B., Van Loon, E.E., Hooghiemstra, H. & Verstraten, J.M. 2008. Analysis of plant biomarkers greatly improves reconstruction of palaeo-environments. Geology (submitted).

*RUFLE stands for Reconstruction of the Upper Forest Line in Ecuador