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Data

Dating of slope sediments and alluvial deposits in the Aburrá Valley, Colombia

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Introduction

The Aburrá Valley is located in the northern part of the Central Cordillera of Colombia. As shown in Figure 1, densely populated areas occupy the central portion of the valley. Due to relatively high precipitation, remarkably weathered rocks and mobilization of the tropical soils, re-deposition is active on the slopes and along the major river slopes.

Absolute dating provides the temporal framework necessary to understand the geologic and geomorphologic development of the valley during the Quaternary Period. Relative and absolute dating methods have been applied to sediments in the Aburrá Valley in recent years, in an attempt to unravel the age of this significant topographic structure. Several ^{14}C and fission track ages have been reported by some authors (Restrepo, 1991; Toro, 1999; Ortiz, 2002; Yokota and Ortiz, 2003).

^{14}C and fission track dating were carried out in this study to determine deposition periods of the slope deposits in the Aburrá Valley. Organic and ash horizon samples were collected from several sites in the valley.

Slope sediments and alluvial material distribution in the Aburrá Valley

The Aburrá Valley has a length of 65 km, and ranges in elevation from 1,000 m to 3,000 m. The morphology of the Aburrá Valley is characterized by alluvial plains along the Medellín River, bounded by gentle to moderate step-like slopes along the riverbanks. The geomorphologic characteristics of the valley change slightly along the course of the Medellín River. In the southern portion of the valley the cross section is narrow and asymmetric and slopes are relatively steep, but in its central portion the topography becomes smoother and wider, with gently to moderately inclined slopes. The valley section again becomes narrow in the northern portion but remains symmetrical (Fig. 1).

The bottom of the valley comprises alluvial sediments, which range from 2 to 7 km in width. These sediments were accumulated by the Medellín River and its tributaries (Fig. 1). The sediments consist of fine- to medium-grained sand, and lithologically heterogeneous well-rounded pebbles. Thin layers of highly plastic peat are intercalated within the alluvial sediments, which are interpreted as flood plain deposits (Rendón, 2003). Gentle slopes occur in the central valley (Fig. 1). These surfaces are characterized by gently to moderately sloping terrains. In plan view, they are straight, concave, and little to moderately dissected. A typical cross section is represented by staircase-shaped slopes. Clear differences are recognized among step levels in degree of dissection, inclination, and relative height above the Medellín River, representing different stages in the evolution of the slopes (Aristizábal, 2004).

These gentle slopes consist mainly of slope sediments derived by debris flows. These sediments are mostly massive, poorly sorted, matrix-supported, and range in size from clay through cobbles to boulders. The clasts are subangular and angular in shape, and are amphibolite, gneiss, granitoid, basalt, or dunite in rock type. Matrix / boulder ratios vary between 40:60 and 20:80.

Several ages have been reported for slope sediments and alluvial material from the Aburrá Valley. Restrepo (1991) obtained a zircon fission track age of 2.04 Ma from volcanic material in a debris flow. Toro (1999) reported a fission track age of 3.06 Ma from volcanic zircons in tilted alluvial terraces in Caldas town. Based on numerous fission track ages and previous data, Toro (1999) determined that deposition of recent ash over the Aburrá Valley began at 0.44 Ma. Ortiz (2002) reported tuff involved in a debris flow around La Estrella town, and dated at 0.62 Ma. Ortiz (2002) also reported a fission track age of 0.15 Ma from an ash horizon covering debris flows in the Boquerón Pass area. Finally, Yokota and Ortiz (2003) dated an organic paleosol covering gravel beds at 1.4 ka.

Sampling location

Organic material was collected from alluvial sediments in the southern Aburrá Valley for this study (Fig. 1). Sample M_1 is wood fragments, and was found in peat horizons intercalated in gravels and sands. The columnar section of the site is shown in Figure 2. Sedimentary environment of the deposits were interpreted by Rendon (2003) as an

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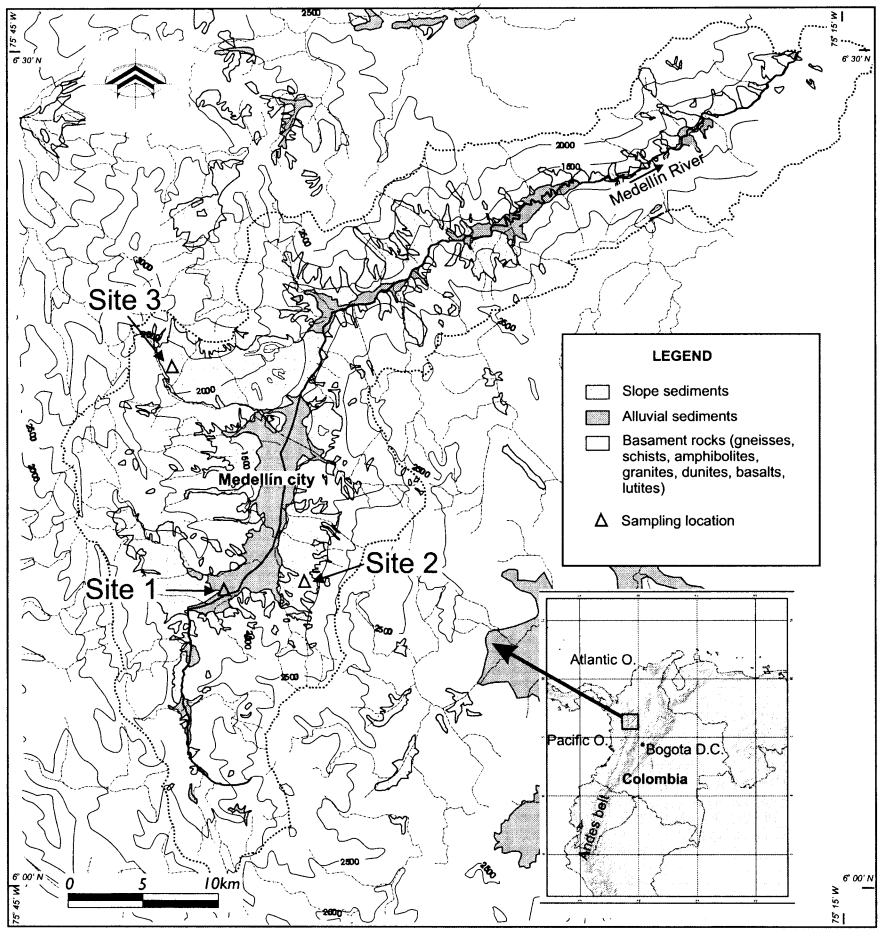

Fig. 1. Distribution of slope sediments and alluvial sediments in the Aburrá Valley, Northern Colombian Andes (Aristizábal, 2004), and location of the sampling sites. The dotted line marks the border of the Aburrá Valley. Gentle slopes are composed of slope sediments. Basement lithologies include metamorphic, granitoid, ophiolitic, and volcano-sedimentary rocks.

alluvial sequence caused by lateral shift of channels on a flood plain. A slope deposit in the upper part of this column contains large, angular, and completely weathered boulders.

Samples M_2 and M_3 are volcanic ash beds collected in the southeastern (El Poblado) and northwestern (Boqueron) parts of the valley, respectively. The El Poblado site is underlain by slope sediments characterized as debris flow with matrix / boulder ratio of 20/80 (Fig. 3). The fragments are subangular clasts of basalts and lutites. The matrix is reddish (10 YR 7/6) silty clay. These sediments are covered by gray volcanic ash 0.6 m thick. The Boquerón sector is also underlain by slope sediments consisting of debris flows deposits in which boulders and gravel are predominant (boulders 40 %, gravel 15 %, and matrix 45%) (Fig. 4). The clasts are subangular amphibolites, and the matrix is again reddish silty clay (7.5 YR 6/6). These sediments are covered by grey volcanic ash 1 m in thickness. Volcanic ash samples were collected from both locations.

Results

^{14}C dating was carried out by the Geoscience Laboratory Co. (Japan). Conventional ^{14}C age was calibrated using the INTCAL 98 calibration program (Stuiver et al., 1998). The M_1 wood sample was processed using acid-alkaline-acid procedure. The age is quoted in conventional ^{14}C years (Table 1) and exceeded the minimal age >39,090 BP available by this method.

Table 2 gives the ages obtained for samples M_2 and M_3. They were dated by fission track on zircons in the Department of Geoscience at Shimane University. Ages of $< 0.19 \pm 0.02$ Ma for M_2 and $< 0.22 \pm 0.05$ Ma for M_3 were obtained based on 62 and 22 zircon crystals, respectively.

Conclusions

^{14}C age of M_1 wood fragments (>40 ka) from alluvial sediments suggests that some of alluvial plain deposits along the Medellín River are very old. Considering that debris flow deposits conformably covering the alluvial

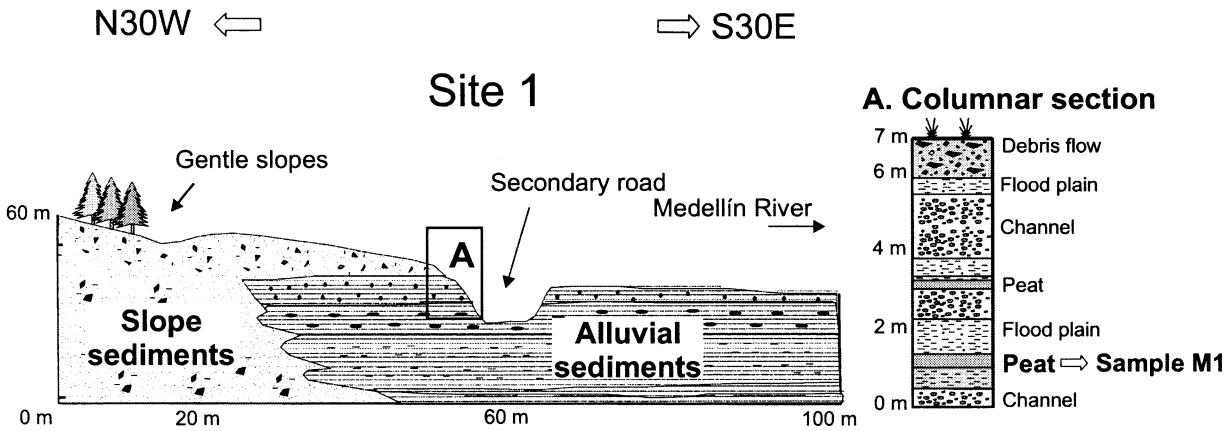

Fig. 2. Cross section and columnar section Site 1. Flat surfaces at the floor of the valleys are composed of alluvial sediments, bounded by gentle slopes formed by slope sediments. Sample M_1 was collected from a peat horizon in alluvial sediments, at a depth of 6 m beneath the ground surface. At site 2 alluvial sediments are covered by 1~2 m slope sediments.

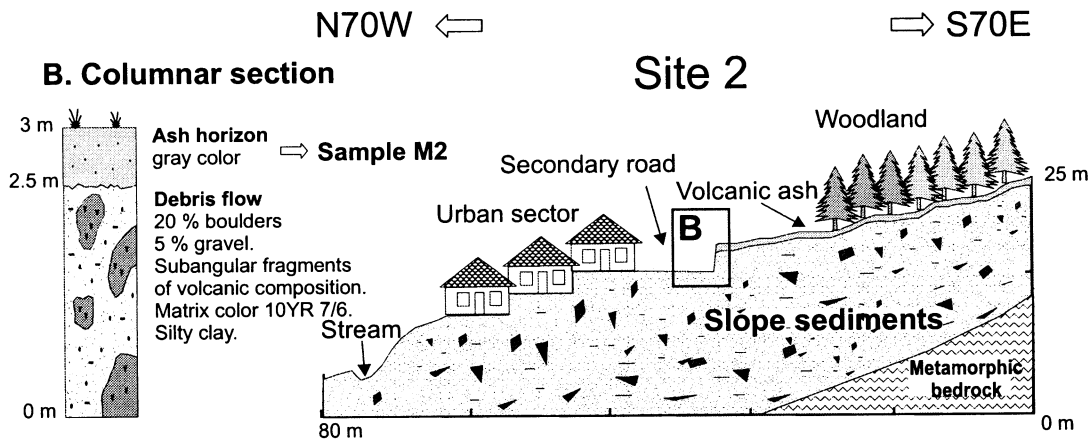

Fig. 3. Cross section and columnar section Site 2. Gentle slopes are composed of thick slope sediments overlying metamorphic rocks. A volcanic ash horizon of 1 m thick covers the slope sediments.

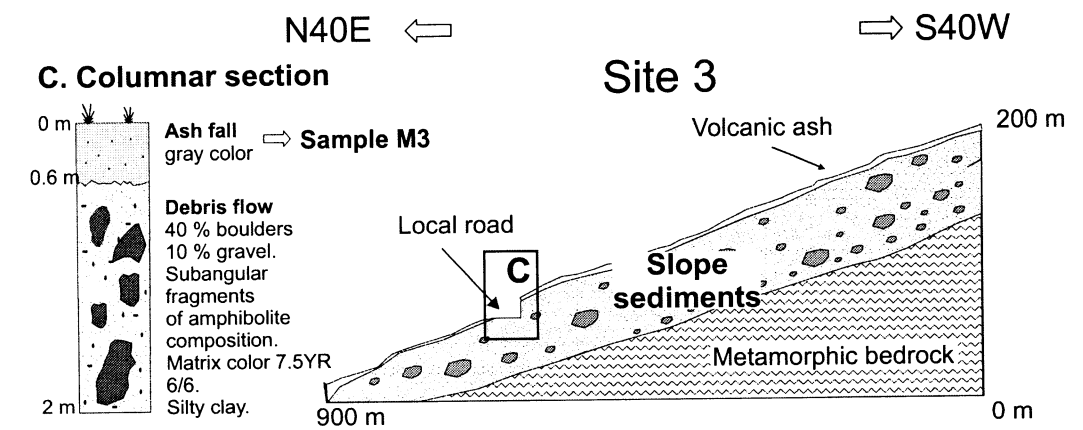

Fig. 4. Cross section and columnar section Site 3. Gentle slopes are composed of slope sediments overlying metamorphic rocks. A volcanic ash horizon of 1 m thick covers the slope sediments.

Table 1. Radiocarbon date from wood samples in peat horizon intercalated into alluvial sediments of the Medellín River (Beta Analytic Inc.).

Sample no.	Depth (m)	$\delta^{13}C$ (‰ PDB)	Conventional ^{14}C age (years BP. ± 1 σ)
M_1	6	− 29.6	> 39,090

Table 2. Fission track data from volcanic ash horizons covering slope sediments in the El Poblado and Boqueron sector.

Sample no.	No. Crystals	Spontaneous ρs (Ns) ($10^6 cm^{-2}$)	Induced ρi (Ni) ($10^6 cm^{-2}$)	Dosimeter ρd (Nd) ($10^5 cm^{-2}$)	$P(x^2)$ %	Age ± 1 σ (Ma)
M_2	62	0.295 (64)	5.77 (12515)	1.88 (6209)	100.0	< 0.19 ± 0.02
M_3	22	0.32 (22)	5.31 (3651)	1.88 (6205)	99.7	< 0.22 ± 0.05

Ages were calculated using the zeta=393.8 (Nagai et al., 2004) and neutron irradiation was carried out at the Tc-pn facility of KUR reactor of Kyoto University.

deposits, deposition of the slope sediments in the lower slope around San Antonio de Prado and La Estrella town may be during the middle to late Pleistocene.

The fission track ages from site 1 (< 0.19 ± 0.02 Ma) and site 2 (0.22 ± 0.05 Ma) represent youngest values for the deposition of slope sediments. These results suggest that slope sediments in the El Poblado and Boquerón sectors were also deposited during the middle to late Pleistocene.

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