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ORIGINAL ARTICLE

Geometro or How to Discover a Valley's Geomorphology by an Integrated Transportation System in Medellin (Colombia)

Claudia Aguirre Minvielle · Michel Hermelin

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Abstract Medellin and suburbs form a large city, currently with over 3,200,000 inhabitants. The complex, located in a relatively narrow valley of the Central Cordillera at 6°N, is dominated by plateaux and peaks reaching 3,000 m. The geology is complex, probably formed under the influence of tectonic agents more than two million years ago. The Geometro project was born from the initiative of two regional scientific societies, Parque Explora, a local interactive museum geared to the popularization of science, and the "Colombian Academy of Sciences". It is designed to characterize the geomorphology of the valley and the local population, from the elevated railway and cable car lines that are included in the project. Geometro is primarily designed for children and adolescents, the main beneficiaries of Parque Explora. After a half-hour oral presentation by a specialist and a set of activities for completion, they will take the aerial train in groups of 15, under the guidance of instructors (geology students) with prior training in the field. They will show the young people a view of the landscape based on the Earth Sciences. A brochure will also be published for the general public, explaining the varied scenery as seen from the metro, from a geomorphological point of view. To complete the project, a second booklet written with scientific terminology, will be produced.

C. A. Minvielle
Parque Explora, University of Bourgogne,
A. A. 56 213 Medellin, Colombia
e-mail: claudia.aguirre@parqueexplora.org

M. Hermelin (✉)
EAFIT University,
cra. 52 No. 73 75 Medellín, Colombia
e-mail: hermelin@eafit.edu.co

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Introduction

The Geometro program was initially inspired by the 10-year-old two-line aerial metropolitan train (the metro) in the city of Medellin. Recently, two cable car systems, the first ones in the world built for the mass transportation of people, have been added to these two lines. The city spreads along an Andean valley with a topography that is ideal for the appreciation of landscape and the inference of geological structures. Furthermore, another cable car system has been recently added to the K (east) metro line. This new system reaches one of the plateaux that overlook the valley, which allows a much more complete view over it (Fig. 1).

The second idea behind this program stems from the creation in 2007, of Parque Explora, an interactive museum dedicated to science that opens all year long and has a room specializing in Earth Sciences called Colombia Geodiversa.

The Earth Sciences content in basic and secondary educational curricula in Colombia is practically non-existent. Our program, aimed primarily at school children and youngsters but also at adults, is designed to redress the local people's lack of knowledge of their valley, which happens to be particularly complex from a geological point of view. This project will not solve all of the valley's problems, but it is hoped it will contribute to the solution.

Our challenges (Giordan and Souchon 1991) include:

- Getting people to know the landscape, now mostly covered by the city, from a geological and geomorphological perspective;

Fig. 1 Aerial cable cabins of one of the two secondary lines completing the Medellin Metro main rail in the steepest parts of the city

- encouraging children, youngsters, and adults to understand that beneath the buildings and streets lies a foundation of a variety of rocks, put in place by processes that are still active and dangerous in some areas;
- giving the inhabitants an understanding of the geological landscape and its evolution; showing them that this environment should be understood and appreciated, not just for its esthetic qualities but for its associated risks, that have led to much human loss.

Similar to the majority of Latin American cities, Medellin has mushroomed, from 200,000 inhabitants in 1950 to 3,500,000 at present. A high percentage of these people live in conditions acknowledged as dangerous, due to their exposure to natural risks, such as floods, flash floods, landslides, and earthquakes. It is therefore necessary to inform without inducing fear and to teach without exaggerating, but also without hiding, the facts.

The Geometro plans were inspired by the National Congress of the American Geophysical Union in San Francisco, California in 1984, where Geologist Clyde Wahrhaftig organized an excursion by streetcar, and gave it the provocative title, "Streetcar to subduction!", no doubt inspired on Tennessee Williams' play, "A streetcar named desire".

Without presuming the same degree of success that Wahrhaftig had with his book (Wahrhaftig 1984; a text impossible to get nowadays), we hope however that our initiative will arouse the interest of Medellin's children—and hopefully also that of adults.

Everybody can gain through this project. The role of each institution is essential: this includes Explora's support in bringing together groups of children and in providing the necessary logistics in the pre-journey training; and also the knowledge, experience, and mastery offered by the Colombian Society of Geology and the universities. Furthermore, Explora can also offer new job opportunities for young geologists.

Geographical Setting

Topography

The Aburra Valley is located in the northern Central Cordillera at 6° 30 N latitude. It consists of an elongated topographic depression composed of two areas: the southern one, with a North–south direction and a length of 30 km; the other one stretching 35 km in a North-East direction. The Medellin River runs along the bottom of the valley at altitudes from 1,800 m a. s. l. to 1,400 m. The valley, starting from the south, is initially narrow and opens in the Medellin area, where it reaches a width of 7 km; it is bordered by mountains which reach 3,000 m a. s. l. and by plateaux ranging from 2,600 to 1,800 m a. s. l. (Fig. 2).

Climate and Vegetation

Climate in the Medellin valley has the following characteristics:

- Average temperatures range from 22° to 13°C, depending on the altitude, with day/night variations but no seasonal thermal changes.
- Rainfall reaches maximum values of 3,000 mm per year in the southern limit; 1,500 mm in Medellin and 1,400 mm in Bello. Precipitation is controlled by topography: the general direction of trade winds (NE) is modified when the valley becomes oriented north–south in Bello and rainfall tends to increase southward, where the valley becomes narrower and humid air masses start ascending and condense.

The climate of the valley is also influenced by changes in the location of the tropical convergence zone, which crosses the area in March–April and in October–November and produces higher rainfalls.

Vegetation in the valley includes humid to hyperhumid mountain forest with precipitation between 1,400 and 3,500 mm per year and average temperatures from 10°C to 22°C. This means that before human settlements the entire valley was covered with dense vegetation, excepting perhaps steep rock outcrops and flooded low alluvial plains (Pérez 1993).

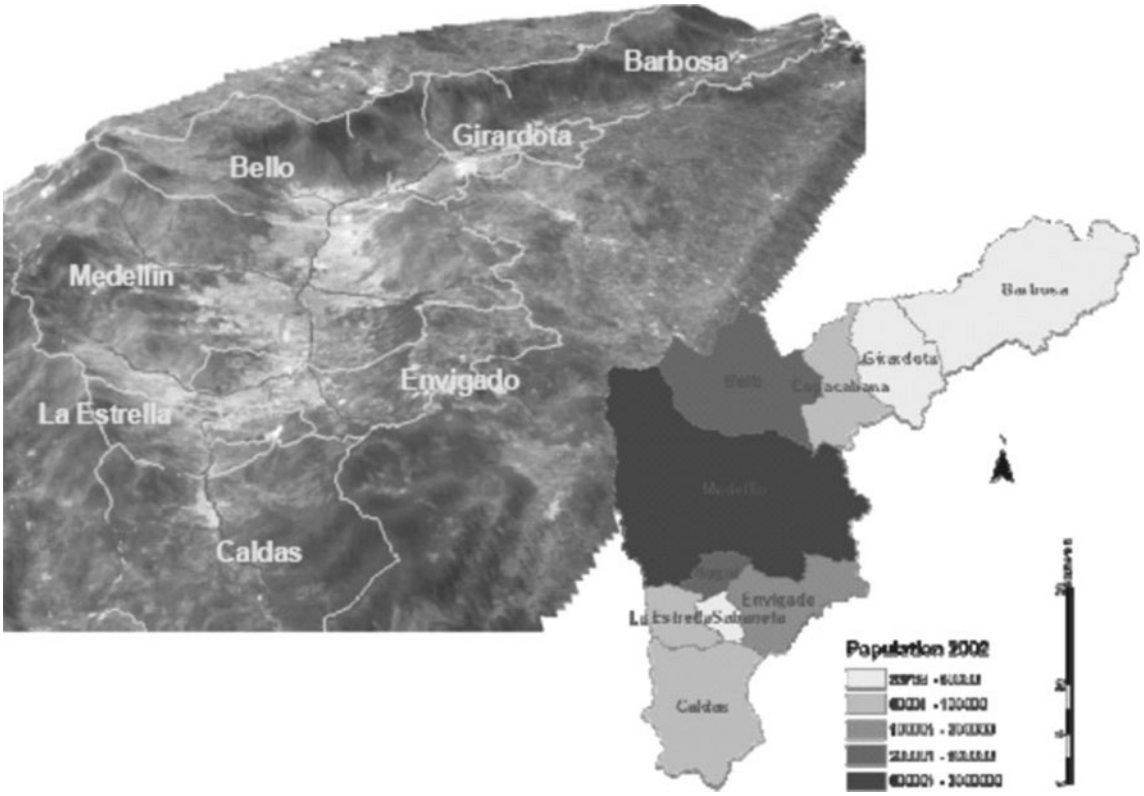

Fig. 2 DTM representation of the Aburra Valley showing the location of urban areas

Hydrology

Net drainage is determined by the Medellin river and its torrential tributaries. Most of the latter originate within the valley, but some come from the surrounding plateaux and some may have a pronounced structural control related to faults and lineaments. In its upper part, the Medellin River is torrential itself and partially associated with the Romeral fault, a major structural feature in the region.

Geology

The Aburra Valley has a complex geological composition due to the presence of several nearby allochthonous accreted terrains and of the strong tectonic influence of the Cauca Romeral fault systems (Fig. 3). Three main lithological units exist and stretch from the Ecuadorian border to the northern Caribbean plains (Maya and González 1995):

Central Cordillera Polymetamorphic Complex

This complex corresponds to a large metamorphic belt, characterized by a great variety of lithofacies. Its western limit is the Romeral fault system, represented in the valley by the San Jerónimo fault. In the valley, this complex presents several compositional varieties. Southward, near the town of Caldas, lies an elongated body of orthogneiss (343 Ma (K/Ar) and 391 Ma (Rb/Sr)). Other gneisses are found near Envigado, in intrusive contact with schists and amphibolites, exposed in the valley's western flank towards the north. These have a different composition, and become granulites and migmatites eastward, outside of the valley. The amphibolites have been subject to several interpretations: apparently several groups exist, besides a series of metagabbro bodies, which are associated with an old ophiolitic complex. Most of the amphibolites are associated with a Triassic metamorphic event (226 Ma, Sm/Nd).

Quebradagrande Complex

This vulcano–sedimentary complex corresponds to a discontinuous belt limited by structural features. Its eastern limit is the San Jeronimo fault, which separates this unit from the Central Cordillera Polymetamorphic Complex. The Quebrada Grande Complex consists of sedimentary and volcanic rocks; furthermore, it comprises highly tectonized dunitic and gabbroic bodies. The sedimentary sequence corresponds to cherts, greywackes, and black siltstones from early Cretaceous. Volcanic materials are tuffs, agglomerates, andesites, and basalts; K/Ar dating gave also an early Cretaceous age (~105 Ma). The

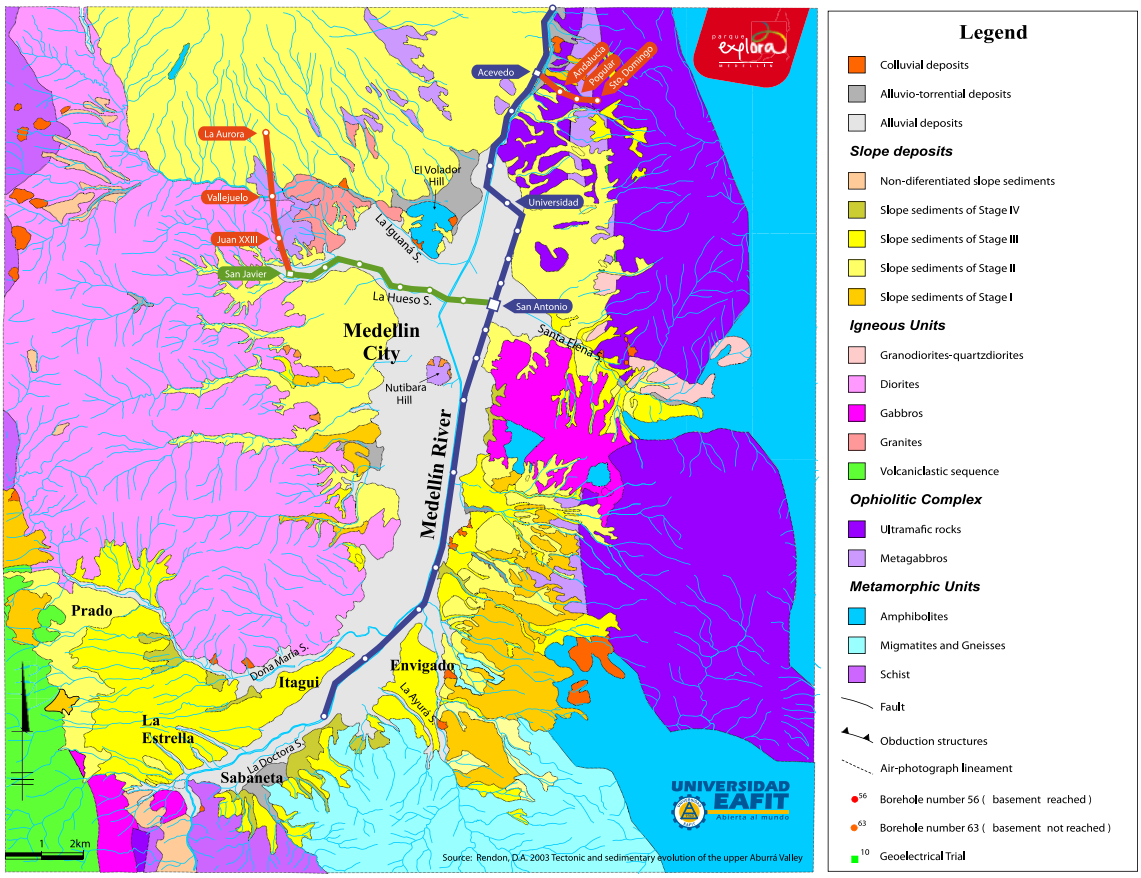

Fig. 3 Geologic map of the central part of the Aburra Valle. Main Metro lines area shown in *blue*, cable lines are in *red*

geodynamic interpretation of these oceanic rocks is still in discussion.

Ophiolitic Complex

Several ultramafic igneous bodies are present in the Aburra Valley, characterized by a high degree of deformation, faulted contacts, north–south orientation and lenticular shape. Some authors prefer to divide them into two different complexes, although no final agreement has been reached. In the southern part of the valley and associated with the San Jerónimo fault and its related structures, several dunite, peridotite and gabbro lenticular bodies are found. These have been dated as late as Jurassic-early Cretaceous.

Another group of similar bodies were found in the upper part of the valley. With respect to the origin of the unit, several hypotheses exist. It was initially interpreted as the result of obduction above the Central Cordillera Polymetamorphic Complex, which occurred about 102 Ma ago. More recently, a new model has been presented in which the obducted sequence is much thicker and includes the underlying amphibolites; the entire sequence in considered to have suffered regional metamorphism, which implies an older age for these rocks and their emplacement.

Plutonic Bodies

Several plutonic bodies are present in the Aburra Valley. In general, they have different compositions and their age is Cretaceous. During this time, there was an abundant production of oceanic crust, represented by the rocks which constitute the western Cordillera. It is possible that the subduction rate was higher at that time than at present. The Antioqueño Batholith is the larger one and forms the northern part of the Aburra Valley, which was excavated from it. It consists of several satellites: the Ovejas Stock, which forms the western slope in the Bello area; and other smaller bodies, exposed in the eastern center of the Valley, known as Las Estancias Stock (Santa Elena) and Media Luna Stock.

Two other plutonic bodies occur in the Aburra Valley: the Altavista Stock, in the western central area, which is characterized by its older age, its broad compositional variation (including diorites, gabbros, granodiorites) and its hypoabyssal facies of andesites and porphyries; and the San Diego Stock, located in the central eastern area, which consists of gabbros and diorites.

The intrusive relationship between these plutonic bodies and the Central Cordillera Polymetamorphic Complex suggests that the associated magmatic events

occurred after the early Cretaceous oceanic crust obduction. Furthermore, most of these bodies are affected by north–south faulting, suggesting a significant tectonic activity after their emplacement.

Unconsolidated Deposits

One of the fundamental characteristics of the Aburra Valley is the presence of thick and extensive unconsolidated deposits which include alluvial, torrential, colluvial, and mud and debris flow deposits. They cover almost entirely the bottom of the valley and important parts of its slopes; in total, more than 50% of the valley surface. Their predominance justifies their consideration as an independent geological unit. Several of these slope units have been dated as late Tertiary.

Systematic geophysical exploration shows an irregular hard rock basement which defines at least three closed basins associated with regional tectonic features; this indicates a strong tectonic component in the origin and evolution of the southern area. Furthermore the composition of these deposits is strongly influenced by slope movements and shows an intercalation of alluvial materials with mud flows and debris flows.

Regional Structures

The present distribution of structures and their deformation trends are the products of reactivation of large fault zones inherited from previous tectonic phases. The correlation between main structural trends and geomorphic micro-units is a useful tool in understanding the geological evolution of the area. The basement of this part of the Central Cordillera is predominantly crystalline and the main structures are faults and shearing zones.

At least three main fault systems are present:

- Romeral fault system, which forms the boundary between oceanic and continental crusts. It crosses the SW portion of the valley with a general trend of N10–20°W, and shows a complex lithology and evidence of sinistral lateral displacement; however, the time distribution of these movements is very complex.
- Toward the NW sector of the valley, several tectonic features can be inferred, which form the Belmira System. This is characterized by marked changes in the orientation of the structures and the formation of small lenticular shaped crustal blocks.
- East of the valley, several north–south structures were identified with a moderate topographic expression, known as the Rodas–La Honda System. Some of these features cross the valley and become part of the Belmira System in the north.

Finally within the Aburra Valley, several geomorphic features have been identified: deflected ridges, asymmetrical river trends, slope variations, and others. The orientation and displacement of these structures are very variable.

Geomorphology

The Aburra Valley belongs to the physiographic unit Central Cordillera, which can be defined as a tectonic block with an essentially igneous metamorphic composition, limited by large faults systems with a predominant north–south direction (Palestina in the east and Romeral at the west; Hermelin and Rendón 2007). Furthermore, this unit constitutes part of a landscape unit which could be called the northern region of the Central Cordillera, characterized by large erosion surfaces (plateaux) limited by scarps and canyons. These landscape units can be divided into several geomorphic macro-units, accepting that these units may have undergone secondary changes without losing their original regional entity. One of these macro-units is the group of erosion surfaces near the Aburra Valley. They were formed near sea level and they lie now at altitudes between 1,800 and 3,300 m above sea level, as a consequence of tectonic or isostatic movements. Another macro-unit is the group of canyons which cuts the plateaux; one of them is the Medellin–Porce watershed, which separates two blocks, one in the north (San Pedro and Santa Rosa) and the other in the south, which is called the Oriente Antioqueño. The Medellin Porce unit can be divided into two parts:

- The Rio Porce canyon, located downstream from Copacabana, cuts the erosion surface, forming a V shaped narrow valley with a width of 10–13 km and a depth of 0.9–1.3 km. It has an orientation of N 50° E for more than 30 km.
- The upper Aburra Valley is located upstream and has a rhombic shape, elongated in a north–south direction, with a length of 45 km and a width of up to 23 km. It has a depth of about 1.2 km, but it can reach as much as 1.5 km excluding the sediments. In this segment, several large tributaries such as Quebradas La Miel, Doña María, La Laguna and El Hato may show opposing directions to that of the Medellin River. The SW area shows drainage patterns which indicate a strong tectonic control. The eastern flank and the northern part of the upper Medellin Valley are characterized by a regional scarp which forms the upper part of the slope and generates a right angle with the erosion surface remnants, which can be associated with tectonic features mapped in the valley. Furthermore, slopes in this part of the valley show dramatic changes of inclination, which define a series of steps in a north–

south direction and which may indicate the movements of tectonic blocks within the valley.

Fission track dating, obtained from zircon crystals found in buried volcanic ash layers intercalated in alluvial and colluvial deposits, indicate an age of about 2.6 M years for the Aburra valley opening. This event initiated the deposition of abundant slope deposits which still cover a large percentage of the valley's intermediate slopes. No evidence has been found for significant climate change since the opening of the valley.

On the basis of physiographic criteria, seven types of geomorphologic units were defined: main scarps, secondary scarps, steeps, ridge systems, isolated hills, smooth slopes (in slope deposits), and alluvial plains. In the case of Medellin Valley, this geomorphic framework supports an evolutionary model characterized by the superposition of strong erosive processes on a tectonically controlled landscape.

Recent studies based on detailed stratigraphic description in the El Poblado area, complemented by geomorphological mapping and fission track dating, allow the establishment of a chronostratigraphic model for the deposition of these deposits, which follow a "telescopic" trend (oldest deposits being the highest). At least four series of events were identified with ages from 2.6 to 40 Ma.

The origin of the extensive slope deposits is probably related to primary instability, due to deep fractures and weathered rocks, and to movements triggered both by heavy rainfall and earthquakes. However, no definitive explanation has been established.

On the other hand, the irregular thickness and the composition of the alluvial deposits would indicate that their origin is probably related to the surrounding slopes, as interpreted from their composition, size, and roundness.

Alluvial deposits are found in the central part of the valley, and were deposited by Medellin River and some of its tributaries. Their maximum width is seen in Medellin, reaching 7 km, but they disappear abruptly 3 km northward. In the NE–SW area, their width reaches 2 km and they are extensively quarried for building materials. Their thickness and composition vary strongly along the valley, reaching more than 250 m under the Olaya Herrera airport.

Present-day geomorphic processes are mainly slope movements, caused by heavy and prolongated rainfall or, exceptionally, by earthquakes and flash floods. These are the principal natural phenomena responsible for human loss and damage.

Human influence has also produced many changes, some of them with dramatic consequences:

- Human settlement of increasingly steeper slopes, which has destroyed completely the previous forest hydrological dynamics, has also signified an increase in runoff and concentration time, and in many cases, of slope movements due to excessive rainwater infiltration, or slope instability due to civil works (Fig. 4).
- Building on flood prone areas near the tributary borders has cost many lives and caused destruction.
- The canalization of Medellin River to improve communication between eastern and western parts of the valley, and to reclaim the flat, originally swampy land for building purposes, caused an increase in river velocity and the excavation of its bed. Consequently, hydraulic dams had to be constructed in order to minimize this outcome.
- With increased urbanization, tributaries became more and more contaminated and had to be covered with box-culverts. Despite the construction of sewer networks, these covered torrential streams continue to cause many problems due to sediment accumulation.
- Finally, the extraction of alluvial deposits for aggregates, sand and clay, has left large areas without soil, or transformed into artificial ponds.

Illegal human settlement has been a dominant factor in Medellin: at present, about 25,000 families live in houses built in areas that are considered dangerously vulnerable to destructive events, most notably mass movements and floods.

Parque Explora

Explora is in the northeastern part of Medellin, adjacent to the city's regional university, the Botanic Garden, the Municipal Planetarium, an amusement park and a public square frequently visited by students and locals. This cultural center has been conceived as an urban integrated space, aimed at the cultural and touristic development of

Fig. 4 A recent mass movement (2009) which destroyed six homes and caused 12 fatalities in the eastern slope of the Aburra valley

the city. Medellin considers education, science, and culture as the determinant factors of its future.

Parque Explora is an interactive park created for the public understanding of science and technology. Its 22,000 m^2 of internal area and 15,000 m^2 of public areas can entertain up to 2,000 visitors a day. More than 300 interactive experiences, an auditorium for 3D projections, a television studio, a children's exploration room, experimentation spaces for everyone, and a room for temporary exhibitions turn this museum into the greatest project of scientific and technological outreach that Medellin can offer to its inhabitants and outsiders (Fig. 5). Visitors can enjoy creativity and have the opportunity to experiment, learn in a light-hearted way, and build up a knowledge that makes development, wellbeing, and dignity possible.

Explora's mission is to offer favorable incentives to heterogeneous audiences to acquire some scientific and technological knowledge through its exhibitions and interactive scenarios that, in an always respectful relationship with life, promote a scientific and civic culture, essential in the construction of a better society. Its main objectives are:

- To promote free, leisurely, and interactive learning, that is, through experimentation with nature's phenomena and physical materials, and with the scientific and technological inventions of mankind;
- to stimulate the taste for science and technology through multiple approaches;
- to support the institution's educational work with innovative resources;
- to create new spaces for civic encounters;
- to form public opinion towards science and technology, by reinforcing the importance of participation by communities and allowing them to be the architects of their own development;
- to encourage civic creativity.

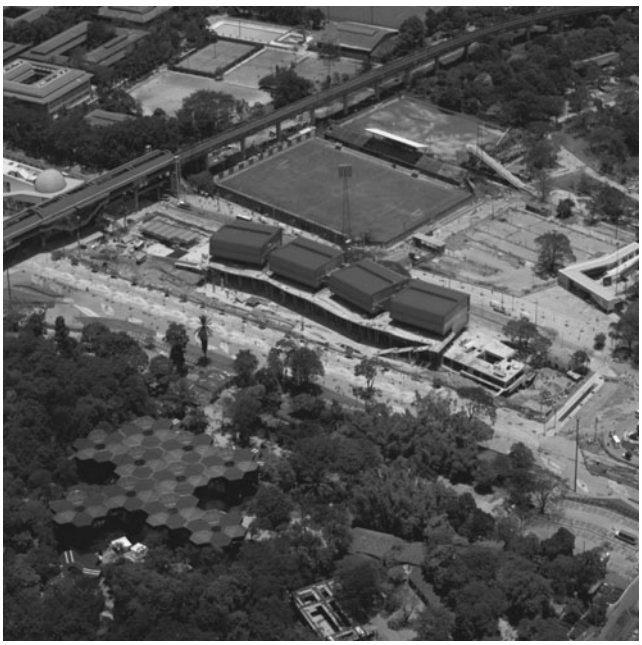

Fig. 5 Air photo of Parque Explora. One of the main elevated metro lines can be seen in the *upper left* corner of the picture

The Activity: Geometro

The existence of the Medellin Metro, the exceptional panoramic locations along many of its routes, and the almost total absence of geoscience topics in basic and secondary school programs (Ministerio de Educación Nacional 2004) have encouraged the authors to propose a program addressed to young people who visit Explora or who keep in touch through the ongoing programs. Moreover, one of Explora's greatest exhibition rooms is dedicated to Earth Sciences (Colombia Geodiversa), which reinforces the purpose of the Parque through its increasing number of activities.

Geometro is an initiative of EAFIT University and the Colombian Society of Geology branch in Antioquia, sponsored by the regional division of the Colombian Academy of Exact, Physical and Natural Sciences. Geometro's main objectives are: to discover the landscape from a geomorphological and geological point of view; to understand that under the streets and buildings there is a foundation made up of a variety of rocks formed and sculpted by different processes, some of which are still active and dangerous (Hermelin and Rendón 2007); and to interpret the primitive landscape and its evolution.

Preparing and Organizing the Activity

To ensure that Geometro is an initiative that goes beyond a simple visit to Parque Explora, it has been necessary to structure it with pedagogical tools: a booklet containing the basic concepts of Geology and Geomorphology and activities that encourage students to measure, draw, and put into practice their observations and measurements made with the instruments provided.

Among the activities are the observation and handling of representative rock samples from Medellin's valley; the samples are located around a large scale map of Medellin, housed in Colombia Geodiversa's room, along with a geological diagram of the region to help with interpretation (De Castro 1997).

One important part of the project is the training of instructors, who are university students from different Earth Science programs. This young staff has been trained to interact with the students registered in the project, as well as document and train the teachers that will accompany

them (Giordan and Souchon 1991). Finally, Parque Explora has prepared a special experimental activity for the project, related to rock and landscape formation (Fig. 6).

Before the Journey

As with all pedagogical routes, this journey must be undertaken with the teachers' support, in addition to basic logistical support. Teachers must become familiar with all of the equipment that will be at their students' disposal (compasses, maps, GPS). It is very important that the teachers never feel disadvantaged or vulnerable with regard to any of the subjects dealt with, since this could alienate them and render them unsupportive.

The teachers' preparation will consist of a 2–3 h session in the exhibition room Colombia Geodiversa, where they will be shown the route and proposed activities, including compass and GPS use and map reading. Furthermore, they will work out the experimental activity developed for the journey's preparation and will be given basic documents regarding the valley's geology and geomorphology. Although the instructors will act as guides during the journey, teachers must also be able to answer any students' questions.

According to each group's school schedule, students usually begin their visit to Explora at 8:00 a.m. or at 2:00 p.m. The time schedule for the visit and trip is as follows:

- 0:00 to 0:15: Welcome
- 0:20 to 1:20: Colombia Geodiversa's room
  - Introduction to geology: interactive work session and activities, using rock samples from the valley
  - Work with maps: how to use them, map conventions
  - Introduction to compass and GPS use
- 1:30 to 2:00: Experimental activity: "delicious rocks"
- 2:00 to 2:30: Break

Fig. 6 Partial view of the Colombia Geodiversa room in Parque Explora, dedicated to Earth Sciences

- 2:40 to 4:00: A journey on the Metro
  - On the basis of the landscapes that they offer, four metro stations have been initially selected as observation points because they show some of the main characteristics of the geomorphology of the valley. At these points, the group carries out some of the booklet's proposed activities. At the final station (La Aurora), the group will compare observations
- 4:00 to 4:10: Departure from Parque Explora

Unlike conventional pedagogical routes, Geometro only uses one of Explora's exhibition rooms, because time is very limited. Therefore, it is important that registered groups have visited the park before.

After the Visit

The important aspect of this program is that it should not be regarded as a one-off activity. We hope that this journey will represent the beginning of other activities that will involve students in the Earth Sciences and motivate them to continue observing and reording, etc.

Instructors will visit the schools that have participated in this induction program. They will answer students' questions, assess their maps, and propose new activities, based on the local environment and landscape of the institution (such as observation, maps, samples, analysis). The instructor will also suggest a new experimental activity related to the geosciences.

We hope that this interaction will stimulate new questions that may form the basis for research projects good enough to be included in the Explora's Science and Technology Fair that takes place every year.

It is hoped to create a fresh interest in the Earth Sciences through Explora, with activities assigned to different rooms, using tools such as Google Earth, and establishing relationships with institutions such as SIMPAD (the local system for the prevention and warning of disasters), which is responsible for a large number of the valley's meteorological stations.

This proposal will also be presented to public and private institutions that are connected with the environment, disaster prevention, geology and geography schools, geologists' associations and Medellin's Metro, etc., in order to gain economic support and to extend this program to a greater number of students and the general public.

Future Developments

In addition to these trips and the short visit to Explora, we plan to complement this familiarization and appreciation

program of the Valle de Aburrá with the following activities:

- In the recently built public libraries in the city's most disadvantaged neighborhoods, viewpoints will be established and equipped with simplified reproductions of the landscape, indicating the most important places, along with their corresponding geological and geomorphological profiles and maps. Visitors will have at their disposal explanatory brochures regarding the landscape, prepared by Explora.
- The establishment of similar public viewpoints on tourist routes around the city, sponsored by the local government.
- The edition and publication of a booklet addressed to the general public, explaining in simple terms, the origin and geological and geomorphological composition of the landscapes that can be seen from the metro and cable cars.
- The planning of a scientific electronic publication, aimed at professionals. This publication will summarize and update the available knowledge on the valley's origin and evolution.
- The organization of a biannual scientific symposium, accompanied by a series of conferences for the general public, with the purpose of updating knowledge and controlling natural and urban processes within the valley. These activities will take place in Parque Explora and will be promoted by the local branches of the Colombian Academy of Sciences and the Colombian Society of Geology.
- Explora will sponsor the installation of meteorological stations in schools, enabling students to make measurements and compare their results with those published daily on the internet.
- Finally, in response to a recent cable extension to the Arvi Natural Park, which is located in one of the plateaux at 2,600 m a.s.l., a new itinerary is being prepared and will include a short excursion showing children a totally different view of soils, vegetation and landscapes to those found in the Medellin valley.

It is anticipated that this project will help to improve the deficient teaching of Earth Sciences in primary and secondary schools of the Aburrá valley, and will enable children to become more familiar with their surroundings through direct contact with nature. Though a simple concept, it is hoped that Geometro will represent a real innovation in the way that young people perceive their environment.

References

De Castro C (1997) La geografía en la vida cotidiana. De los mapas cognitivos al prejuicio regional. Ediciones del Serbal, Barcelona

Giordan A, Souchon C (1991) Une éducation pour l'environnement; Z'éditions, Nice

Hermelin M, Rendón D (2007) Medellín y el Área Metropolitana del Valle de Aburrá In Hermelin M (ed) Entorno Natural de 17 ciudades de Colombia. Sociedad Colombiana de Geología, Academia Colombiana de Ciencias Exactas, Físicas y Naturales, Fondo Editorial EAFIT, Medellín, pp 187–211

Maya M, González H (1995) Unidades litodemicas en la Cordillera central de Colombia. Bol Geol - Ingeominas, Bogotá 35(2:3):43–57

Ministerio de Educación Nacional (2004) Formar en Ciencias ¡el desafío! Lo que necesitamos saber y saber hacer. Estándares básicos de competencias en ciencias naturales. Serie Guías 7, Bogotá

Pérez C (1993) Los ecosistemas del valle de Aburrá, pasado, presente y futuro in Memorias del Seminario Una Mirada a Medellin y el Valle de Aburrá. Universidad Nacional de Colombia, Sede Medellín, Biblioteca Publica Piloto, Consejería Presidencial para Medellín y su Área Metropolitana, Alcaldía de Medellín, Medellín pp 63–103

Wahrhaftig C (1984) Streetcar to subduction and other plate tectonic trips by public transport in San Francisco. American Geophysical Union, Washington