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Geomorphological features and processes in the Sierra de Famatina, La Rioja

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ABSTRACT

The Sierra de Famatina is considered the highest elevation outside the Argentine Andes Cordillera, being the General Belgrano hill, 6097 masl, the main height. This altitudinal situation favored the development of glaciers during the cold events of the cyclical Quaternary climatic fluctuations, giving shape to a territory with very complex morphologies. The aim of this contribution is to describe the current and past geomorphological processes in the vicinity of the highest sector of the Sierra de Famatina through different forms of the landscape, which put together allow the recognition of the geomorphological evolution of the region. At present, extreme weather lead to periglacial conditions above 4000 m and glacial above 6000 m, generating ice and snow patches almost without movements in flat to flat-concave sections of the watersheds, and rock glaciers, gelifluction lobes and earth hummocks in cirques, troughs and walls of valleys. Depending on the features of glacial accumulation, three cold events can be recognized, the youngest one (MIS2) with limited distribution, is restricted to the heads of troughs and cirques, from whose deposits the rock glaciers develop. The second one, observed near Puesto Tres Piedras, is represented by moraine-shaped glacier deposits above 3000 m height, and would belong to the Middle-Late Pleistocene. The oldest glacier deposits, early-middle Pleistocene, are in higher topographies. Below 3000 m, valleys are rocky and steep-sided, with permanent courses due not only to low rainfall, but mainly to the melting of the permafrost, forming important reservoirs of water.

1. Introduction

The Sierra de Famatina (SF), one of the main constituents of the morphostructural region known as Famatina System, is located in the north center of La Rioja Province, between 27° and 30° south latitude. The SF is characterized by mountain ranges that surpass 6000 masl, which are the highest of the continent out of the Andes Cordillera. The General Belgrano hill (6097 m) is, together with others lower ones (Overo Negro, El Overo, El Pelado hills, among others; Fig. 1), the highest elevation of the whole system. This feature, along with climatic and paleoclimatic issues, favored that not only in the present and the Quaternary, but mainly during cold times, much of its surface has been occupied by glaciers.

Currently, extreme climatic conditions allow the persistence of small patches of snow and ice at the highest altitudes, being the periglacial processes the most important, not only by their intensity, but also by extension (IANIGLA, 2017).

2. Geological setting

The tectonic style of the Famatina System responds to the interaction of the basement and the sedimentary cover, with high-angle thrusts that are strongly controlled by the structuring of the crystalline basement and scaling systems with vergence to the west. It is made up of a low-grade metasedimentary basement and an important Ordovician sedimentary and volcanic-sedimentary cover that allow its separation from the Sierras Pampeanas located eastward and westward. Simultaneously, a calc-alkaline magmatism was developed, and later, extensional tectonics of the Gondwana Cycle facilitated the intrusion of peralkaline leucogranites. During the Tertiary (Andean Cycle), riodacitic and dacitic intrusions gave rise to wide areas of hydrothermal alteration with diverse mineralization and strong lifting along inverse faults resulting in the current arrangement (Candiani et al., 2011). On this structural arrangement the action of the most recent geomorphologic processes gave the present landscape, which changed according to paleoclimatic changes and neotectonic movements.

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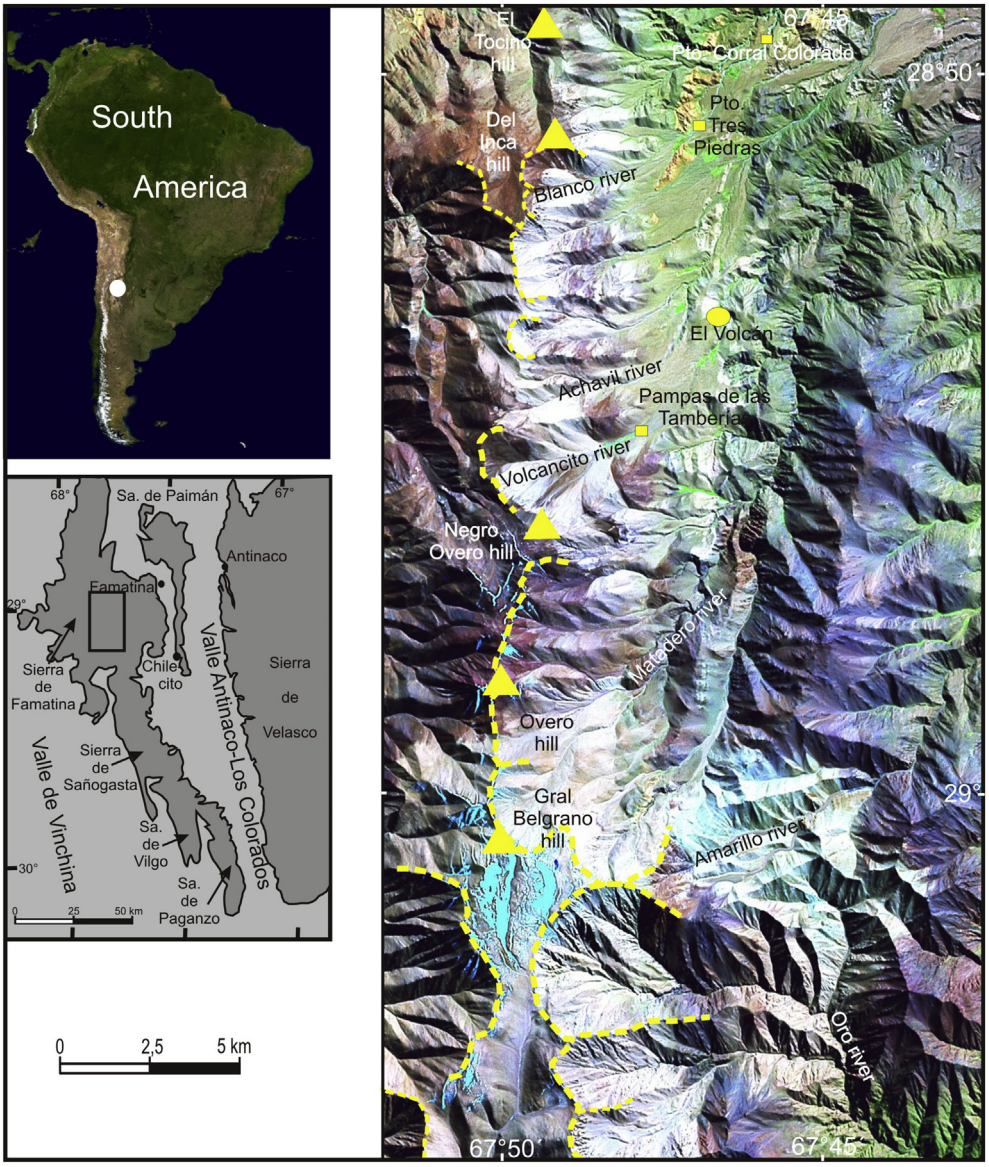

Fig. 1. Location map.

3. Background

Geomorphological aspects of the Famatina System have been little studied, except for general approaches to the types of processes, their intensity and chronology. Bodenbender (1916) was one of the first to refer to the glacial processes in the Famatina System. Although he briefly described these deposits as “moraines”, he reported the existence of past glaciations in these mountains. Later, Turner (1971), Fauqué and Caminos (2006), and Candiani et al. (2011), mapped and briefly characterized these deposits within the area originally defined by Bodenbender, and limiting to General Belgrano hill, Pampa de las Tamberías and surrounding areas. Garleff and Stingl (1996) performed detailed studies on periglacial processes and suggested for 30,000 years BP, more humid conditions above 5800 masl which led to glacier formation, although more arid conditions during the Last Glacial Maximum (~18,000 years) would have not favored the formation of glaciers but the expansion of the periglacial area.

4. Description of the area and methodology

The Sierra de Famatina has the highest elevation of the whole System, with the General Belgrano (6097 masl), Overo (5930 masl), Overo Negro (5791 masl), and Tocino (4530 masl) as the main hills. These mountains are north-south aligned, forming the watershed that separates the drainage toward the Antinaco-Los Colorados valley eastward, and the Vinchina valley westward (Fig. 1). The major basins draining eastward, because of a watershed offset westward, correspond north to south to the rivers Blanco, Achavil, Amarillo, Oro and Miranda. The headwaters of these courses are located in the surroundings of these hills where the glacial, and current and past periglacial processes, are the most important, followed by mass movement and fluvial processes.

The north-south watershed is soft-shaped near the highest part, grading to more broken-shaped both southward and northward, being very acute in the northern sector. From this watershed arise similar secondary watersheds, whose shapes become smoother and eventually vanish because of glacial, periglacial and weathering processes produced both in space and time.

The study is focused on the headwaters of the Volcancito, Achavil and Blanco rivers, which drain towards the Antinaco-Los Colorados basin and in the vicinity of Puesto Tres Piedras (Fig. 1).

The first approaches on the characteristics of the study area were