

NEW DATA ABOUT THE LA BAÑA LAKE ORIGIN (CABRERA RANGE, NW SPAIN) USING GEOMORPHOLOGICAL AND SEDIMENTOLOGICAL ANALYSIS

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I. INTRODUCTION

La Baña lake is located in the north face of Cabrera Range, in the southwest corner of León province (NW Spain), at 1400 m. The area was occupied by a glacier during the last glacial maximum and there are clear glacial landforms such as cirques, rock-basins, moraines and till deposits.

Close to La Baña lake (6,5 ha.) there is another small pond called La Laguna (0,7 ha). Both of them are the most relevant heritage of La Baña Natural Monument, also declared LIC and ZEPA. The lakes are considered a relevant Leonese Geological Heritage in some publications about this province (Alonso Herrero and Gallego Valcárce, 1995; Fernández Martínez et al., 2009). Due to the well-defined glacial landscape, the lakes were considered to have a glacial origin and official information about this protected area offers this explanation. In this work, we analyze the characteristics of the dammed-lake deposit, offering a more plausible explanation for its origin.

II. STUDY AREA

The Lago valley is 6,7 kilometers long, with altitudes between 1200 to 2079 m. From a geological point of view, it is in the limit between Western-Astur-Leonese and Central Iberian Zones. Lithology is represented by Capas de los Montes (slates, sandstones and quartzite), Armorican Quartzites (white quartzite), Transition Serie (slates, sandstones and quartzite),

Luarca Slates (black slates), Casaio Formation (grey slates, sandstones and quartzite) and Rozadais Formation (grey to blue slates) with some sandstones and quartzite. All of them are Paleozoic (Ordovician) and the last ones are exploited by open-pit mines that occupied more than 300 ha. The relief is an old Hercinic basement destroyed by erosion and uplifted by Alpine Orogeny. The relief is very different than the northern slope (Miño-Sil basin) where valleys are narrower and steeper and than the southeastern slope (Duero basin) where base level is higher.

During the last glacial maximum an icefield occupied the higher part of the range and long ice tongues developed in Bibey (Rodríguez Guitián and Valcárcel Díaz, 1994), Xares and Tera (Rodríguez Rodríguez et al., 2011b) valleys. Other tongues developed in nearby valleys without icefield connection. Equilibrium-Line Altitude (ELA) was around 1520 m (Rodríguez Rodríguez et al., 2011a), similar to the Cantabrian Mountains (Santos-González et al., 2013). In Lago valley some moraines are located more than 200 m over the valley bottom.

III. BACKGROUND

Pioneering studies about the valley considered the deposit to have a glacial origin that dammed the lake (Vosseler, 1931; Carlé, 1945; Llopis Lladó, 1957; Schmidh, 1969; Pérez Estaún, 1978). Only in recent and very short quotes a landslide origin for the lake is considered (Alonso Herrero, 2004; Redondo Vega et al., 2004; Fernández Martínez et al., 2009) but official information about the lake considered it to have a glacial origin (www.jcyl.es), so detailed analysis to clarify the origin were necessary.

IV. METHODOLOGY

After photointerpretation and field work, we chose three different deposits in the lake surroundings. In all of them sedimentology was analyzed through the use of till fabric (Andrews, 1971; Dowdeswell and Sharp, 1986; Benn, 1994). Observations about lithology, clasts shape, grain size and structures were also conducted. A-axis fabrics of 50 clasts per sample (one sample in deposits A and B, three samples in deposit C) were determined. Elongated clasts (long to intermediate axis ratio over 1.5) over 10 cm were chosen because they adapt better to glacier flow and lead to a stronger fabric (Benn and Evans, 1996).

The data were plotted and contoured on equal-area nets using the program Stereo32, developed by Röller and Trepmann (2003). A statistical analysis of the data was performed using the eigenvalue method discussed by Mark (1973) and Benn (1994). Eigenvalues were plotted on biaxial diagram of Dowdeswell and Sharp (1986), which plots S_1 and S_3 values.

V. SEDIMENT ANALYSIS

Macro-fabric analyses are rare in the Iberian Peninsula, with some recent exceptions (Redondo Vega et al., 2010; Santos González et al., 2013b). In this case we used the same technique for three different types of deposits.

Deposit n°1 is located in the base of a steep rock wall. It is a clast-supported deposit, without fines, composed of angular to very angular slates, sandstones and quartzite, oriented downslope ($S_1 = 0,75$). Lithology is the same of the outcrops. We interpret this deposit as scree, where fragments of the rock outcrops were accumulated by gravity.

Deposit n°2 is located in the road access to the lake, and it is a more than 3 meters thick matrix-supported diamicton composed of rounded to sub-angular clasts (with some boulders) of quartzite, quartz, slates and sandstones over the substrate, that is composed of slates. Preferred A-axis orientation is the same of the valley, but S_1 is only 0,58. Half of the clasts are sub-rounded, but the rest are rounded, sub-angulated and angulated. Due to lithology, matrix, heterogeneity in sizes, orientation, roundness, fabric and location we interpret this deposit as a till.

Deposit n°3 is represented by a 15 ha deposit that dammed the lakes. It is a clast-supported deposit with big (some up to 3 meters) and very angular fragments of slates, that are the same of the nearby slope. No fines could be observed in the surface. Fabric is polymodal, with no clear main orientation. Due to lithology, angularity, fabric, deposit morphology and location we interpret it as a rockslide. Any glacial evidence appears in this deposit and any rocks from the cirque are present in this deposit, as occur in deposit n°2.

Comparative analyses of fabrics show relevant differences between the rockslide (girdle), scree (cluster) and till (cluster to isotropic) fabrics, relating to different deposition processes. But also lithologies, presence of matrix and clasts shape are very important in deposits differentiation. The dam deposit is composed of slates from the adjacent slope; quartzite and sandstones from the head valley do not appear and boulders do not show any signs of transport. The shape of the slope, with a scar and morphology of the dam deposit is also consistent with a postglacial rockslide, not with a moraine as some previous works and official information report.

With sediment analyses, previous data and photointerpretation we can offer a glacial geomorphological map and the probable evolution of the Lago Valley. The maximum glacial advance was probably previous to 25.600 BP (Rodríguez Rodríguez et al., 2011b) and the entire valley was occupied by a glacier, in some places more than 200 m thick, connected with Sanabria icefield. No clear evidence of recessional phases are visible, but during deglaciation the ice of the valley was isolated with the icefield and progressive restricted to the cirque.

The lakes' formation must to be post-glacial but paraglacial, seismic or high-precipitation event could be the cause that create the rock landslide. No chronological data are reported yet, so only with analysis of the lakes' sediments an age could be established.

VI. CONCLUSIONS

The analysis conducted in the dam deposit of La Baña and La Laguna lakes and other surroundings deposits, as well as the morphology, indicates that a postglacial rockslide dammed the valley and formed the lakes. There isn't any chronological data yet. This origin is very rare in Spanish mountains and because of this, these lakes are very unique and their preservation is very important. But also, due to their origin, they are fragile because the low consistence of the dam. In fact, this type of lakes normally has short duration (Evans et al.,

2011). In the last 30 years many slate open pit mines are working only 1 km from the lakes. Explosions relating with the works are causing important damages and in recent years La Baña lake has very low water level in summer and La Laguna is completely dry during summer months. Therefore, detailed studies are necessary to preserve these singular lakes.