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Dynamic of the 17th January 1945 debris flow in Chavín de Huantar, Ancash, Peru

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Динамика селевого потока 17 января 1945 г. в Чавин-де-Уантар (департамент Анкаш, Перу)

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Археологический комплекс Чавин-де-Уантар (от 1300 до 400 до н.э.) находится на высоте 3185 м н.у.м. на восточной стороне хр. Кордильера Бланка между рр. Моша и Уаческа в департаменте Анкаш на севере Перу. Ввиду античного возраста он является важным участком для исследования эволюции перуанской культуры. 17 января 1945 г. в 7.00 ледяная лавина, зародившаяся на г. Уатцан (6369 м н.у.м.) упала в оз. Айуиньяраху, разрушила его моренную дамбу, затем прошла до оз. Каруакоча, породив сель («аллювиальный поток»), который далее шел по долине Уаческа, существенно разрушил археологический комплекс Чавин-де-Уантар и небольшой город Чавин. Особенности динамики селевого потока не вполне понятны. В данной статье предложен новый взгляд на генезис события, основанный на полевых исследованиях, дешифрировании аэрофотоснимков и космических снимков высокого разрешения SPOT 5.

The archaeological complex of Chavín de Huantar (1300 to 400 BC) is located at 3185 m a.s.l. on the east side of the Cordillera Blanca between the Mosna and Huachecsa rivers in the Ancash department in the north of Peru. Due to its age, it is considered an important piece in the evolution of Peruvian culture. On January 17, 1945 at 7.00 am an ice avalanche originated in Huatsán Mountain (6369 m a.s.l.), collapsed into Lake Ayhuinyaraju, breaking its moraine dam and continued to Lake Carhuacocha, originating a debris flow ("alluvial flow") that went downstream to the Huachecsa valley, seriously affecting the Chavín de Huantar's archaeological complex and the small town of Chavin. The dynamics of the original flow are not clear. In this paper, we present new evidence about the origin of the event, based on fieldwork, and interpretation of aerial photos and SPOT 5 high resolution satellite images.

1 Location and importance

The archeological complex of Chavin de Huantar is placed at the Huari province, Ancash department, in the named Callejón de Conchucos, en the left margin of Mosna river that born by deicing of the Cordillera Blanca. Chavín de Huantar, is one of the most famed and ancient archeological monuments of the pre-Columbian Peru. The main characteristics of the site, The Lanzón Temple, the Main Plaza and the Circular Plaza, the Tello Obelisk and the Raymondi Stella, ornamented with mythological jaguar, snakes, falcons or eagle, and alligators representations. The famous "Cabezas Clavas", encrusted in the walls, are part of the monumental Chavin's art (Fig. 1). Chavin de Huantar was considered by the UNESCO like a Word Heritage Center.

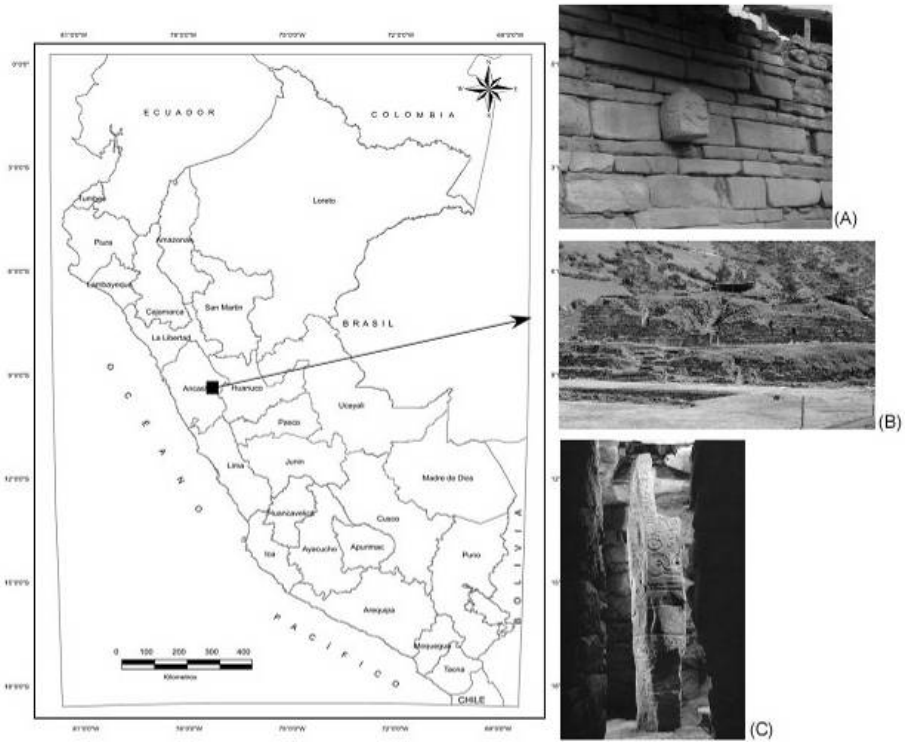

Fig. 1. Location map of the archaeological complex of Chavín de Huantar. (A) Rock made "Cabeza Clava" is the main characteristic of the Chavín culture. (B) Panoramic view of the complex. (C) "Lanzón Chavín", located inside of the archaeological complex. Photos and map by P Valderrama, 2006.

2 Geological context

The geological context of the surroundings of the archeological complex of Chavín de Huantar and the Huachecsa river basin (where the debris flow of 1945 go down stream) is very diverse, highlighting the very cracked jurassic shale in the top part of the Cordillera Blanca and moraine deposits that support glacial lakes, In this zone was the origin of the 1945 debris flow. In the middle part of Huachecsa river basin are some intercalation between cretaceous sandstone and limestone that further the formation of big proportion mass movements, and even valley dams related to them. In the low part of the basin, are river deposits from Mosna River, affluent to Marañón River, and alluvial deposits originated by overlap of ancient debris flows. In this section is placed the archeological complex of Chavín de Huantar.

3 January 17, 1945 debris flow

The dynamics of origin of this debris flow is not clear, because first to the difficult access to the Start Zone and the absence of direct observations after the event, as well as the poor topographic information of the zone.

3.1. Start zone

The 1945 debris flow was originated at Ayhuinyaraju Lake, near to the snow-covered Huatsan Mountain. A mass composed by rocks and ice precipitated inside Ayhuinyaraju Lake (4500 m a.s.l.), at these moment the Ayhuinyaraju Lake didn't contain great volume of water inside. The entrance of the glacier mass produced some sequence of Tsunami Waves which exceeded by far the height of the lateral moraines. This now flow, due to the dynamics generated by the waves, passed over left lateral moraine, eroding it but not destroying it. At the present time, the Ayhuinyaraju Lake does not exist anymore, because the mass filling completely the small basin of the lake (inside the moraine dam).

The flow enter into Carhuacocha Lake (4400 m a.s.l.) located immediately downstream, generating a violent increase of pressure in the natural dam (rock dam?), exceeding and eroding it completely, freeing a violent flow along Alhuaiña ravine (Fig. 2).

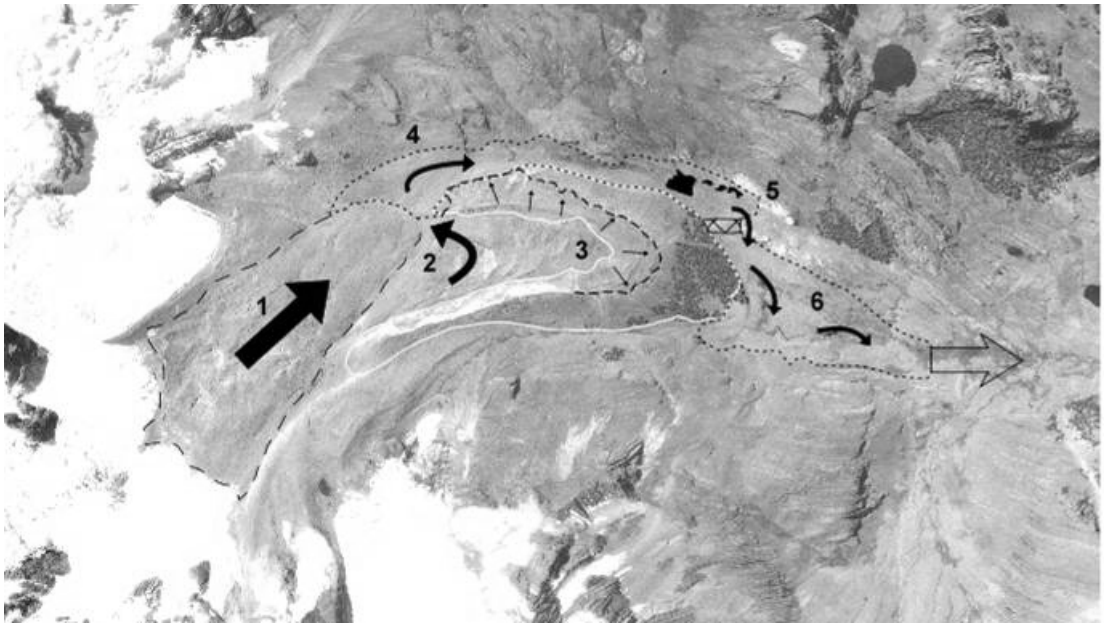

Fig. 2. Dynamics of the origin of the debris flow in 1945. (1) A glacier mass from snow-covered Huatsan Mountain come in into the moraine dam of Ayhuinyaraju Lake. (2) This mass produces the fill of the small lake, creating Tsunamis waves and vent by the right lateral moraine. (3) At the waves moment, it create overflowing marks, the small arrows show them. (4) The flow goes out of the moraine dam and goes downstream to the Carhuacocha Lake. (5) The flow came in into Carhuacocha Lake and destroys its natural dam (showing by a rectangle). (6) The new flow, by more volume and velocity go downstream into the Huachecsa River. Map by P. Valderrama, 2008.

3.2 Trajectory zone

The debris flow went down by the river bed of Alhuiña ravine (with average slope of 20°) carrying a lot of moraine and rock material. With the enlargement of the valley and the reduction of the slope (0° – 2°) the flow decelerates and deposit packsaddles with thicknesses according to the morphology of the terrain, between 0.5 – 10 m, in this zone it deposited approximately 1500000 m^3 of material (Fig. 3). When the valley become narrow and increasing the slope again (6° average) the flow gets faster and eroding the foothills of the mountains in the Huachecsa valley, that event originate several mass movements (Zavala and Valderrama, 2007).

Fig. 3. Trajectory zone of the 1945 debris flow, the dashed lines show the boundaries of the deposit zone. Photo by B. Zavala, 2006.

3.3 Deposit zone

The flow ended up its course in an alluvial fan formed by the overlap of several ancient flows, at the Mosna River debouchments. The flow entered with an approximate height of 6m, creating a deposit of 600 m of length and a volume estimated of material of 900 000 m^3 approximately (Indacochea et al., 1947) covering great part of the archeological complex of Chavín de Huantar and the small town of Chavín (Fig. 4).

Exploration trial pits studies at Chavín's town reveal thicknesses up to 1m of the debris flow in this part of the town. A great portion of the flow material ended up in the Trajectory Zone thanks to the topographic conditions of the high part of the valley.

Fig. 4. Alluvial fan where Chavín de Huantar is located (in white discontinuous lines). The direction of the debris flows of 1945 shows the interrupted black arrow. The small town of Chavín is in the right corner. Photo by B. Zavala, 2006.

4 Final discussion

The origin of the debris flow that affected Chavín de Huantar was due the overflowing of Ayhuinyaraju Lake for the fall of a rock-ice mass from the snow-covered Huatsán Mountain, this flow entered into Carhuacocha Lake (300 meters further down) and destroy its natural dam (rock dam?) emptying it completely. The flow at the trajectory zone deposited an important portion of material due to the decrease of the slope in a dammed valley. However the flow got faster for the morphology of the valley of Huachecsa River taking heights up to 10 meters in some parts of the valley and produced several mass movements.

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