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GEOLOGICAL AND GEOMORPHOLOGICAL FEATURES OF KENAI AND CHUGACH MOUNTAINS IN WHITTIER AREA, ALASKA

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ABSTRACT. – Geological and Geomorphological Features of Kenai and Chugach Mountains in Whittier Area, Alaska. The study presents a petrographic and geomorphologic research in which we identified important aspects of the geological formation and described geomorphological features of Kenai and Chugach Mountains in the Whittier Area, Alaska State. The general objectives are a check-up and presentation of the nature of rocks and typical landforms of glacial models. The field research includes observations on landscapes, the peculiar forms and samples of rocks from various locations, in order to see the local or allochthonous character, knowing that the glaciers can transport materials for long distances. Every rock sample was cut and studied in section at the microscope. The glacial landforms and the types of glaciers existing in Whittier Area were analysed in the field.

Keywords: *geology, geomorphology, rocks, glaciers, Kenai, Chugach, Whittier, Alaska*.

1. INTRODUCTION

Whittier is a little town in the South of Alaska, situated in the NE of the Kenai Peninsula (fig. 1A), on the Pacific shore; it has the coordinates N 60°47', W 148°40'. The geographical territory presents obvious limits, because Whittier is at the head of the Passage Canal of Prince William Sound. The area is surrounded by the Kenai Mountains in the South and the Chugach Mountains in the North. The boundary between the Chugach and the Kenai Mountains is Portage Pass, West of Whittier. Both sectors of mountain chains record heights over 2000 meters and are covered by glaciers and ice-fields, and some glaciers slip into the ocean. The petrographical objective of research was a study of the types of rocks from Whittier Area and of the variety of landforms which have developed on the existing geology, considering that the morphological features are changed by glaciers. Also, the petrographic observations illustrate the geologic formations from the Alpine orogen, Alaska. The observations in the field have a geomorphological nature in the proximity of glaciers action zone. The methods used in this research are at macroscale – in field where sample rocks were taken – and at microscale – the manufacture of the thin sections for the microscope study in polarized light of the mineral characteristics.

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2. GEOLOGICAL SETTING

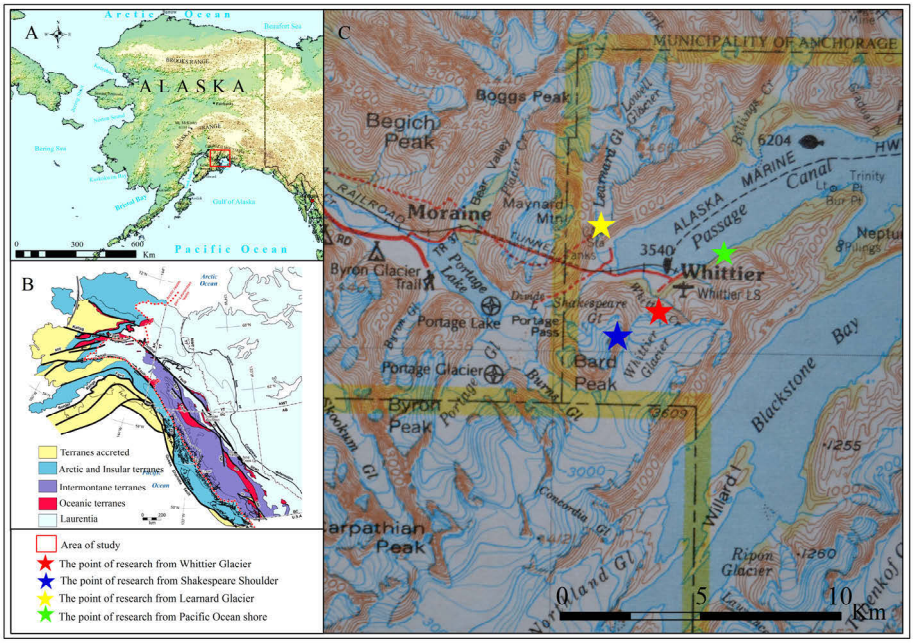

Fig. 1. A. The localization of study area on Alaska physical map. **B.** Geological map of Alaska. **C.** Localization of petrographic interesting points. Source: Alaska – Atlas & Gazetteer with changes.

From a geological point of view, the area is situated on the tectonic compression active line, where the Pacific plate is diving under the American continental margin. The land surfaces in Alaska are continually compressed and folded, which pushes up McKinley Mountain, as well as the rest of the mountains in the Alaska Range. These processes influence the geology of the area and result into various types of associations in the same place: Terranes accreted, Arctic and insular terranes, Intermontane terranes, Oceanic terranes, Ancestral North America (fig. 1B).

The samples of rock examinated were taken from the front of the Whittier Glacier, the front of the Learnard Glaciers and Shakespeare Shoulder – 1071 m (fig. 1C).

The Whittier Glacier is located near Whittier town, about 2 miles South of Passage Canal and 50 miles ESE of Anchorage. The height where we made the research was between 600 m and 800 m along the ice-blocks of the glacier (fig. 2).

The majority of the rocks existing in the proximity of the Whittier Glacier are slates, sandstones and graywackes of Cretaceous age. The sedimentary rocks and terrestrial clastic brought by glacial torrents belong to the Pliocene. The graywackes are highly indurated rocks, whose most conspicuous feature to the unaided eye is the unusual abundance of small angular slate fragments. They are of dark bluish-gray color and at some places are not easily distinguishable from basic volcanics. Under the microscope the graywackes prove to be of rather heterogeneous derivation. There are angular fragments of quartz, containing fragments of feldspar and plagioclase in part.

A little muscovite, epidote, pyrite, magnetite, and zircon are present as accessories. The binding material is a feebly polarizing aggregate flecked with chlorite. In one of the thin sections of the graywackes the vein shows with filling of quartz and edged with the scalenoidri of calcite (fig. 3).

Fig. 2. The field localization of Shakespeare Shoulder and Whittier and Shakespeare Glaciers.

The deposits of moraines situated in front of Learnard Glaciers contain sedimentary rock and metamorphic rocks. These materials originate in the Chugach Mountains (fig. 5). The chain has a general northwesterly trend from Mount St. Elias, and constitute the high barrier between the Pacific coastal belt and the interior. The general petrography of the rocks of the deposit material proves the epimetamorphic schists and the the blocks of sandstones with layers of calcite. The microscopic study indicates that the cleavage of schist assume a schistose foliation, which has become glossy and passed into phyllitic schist. In thin section it shows that the schist is composed of fragments of quartz and sericite.

The rocks found on Shakespeare Shoulder have a magmatic origin and belong to the Kenai Mountains. The graywacke and slates are intruded by quartz diorite or diorite dikes and are probably of Cretaceous age. Under the microscope, the section represents a porphyric monzodiorite (fig. 4). The microscope shows that the rock is largely composed of opaque angular fragments of a greenish-yellow color. Detailed description of the section have a porphyric structure with micrograian basic mass. The composition included dark minerals: quartz-diorite gneiss, plagioclase feldspar, feldspar ortoclaz, sericite, chlorite, calcite. Here such fragments contain phenocrysts of highly altered feldspar.

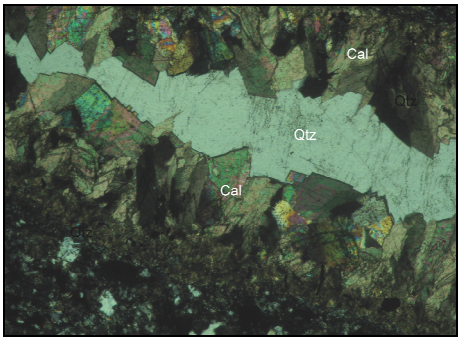

Fig. 3. The microscopical image of graywake with calcite vein (N+), Qtz-quartz, Cal-calcite.

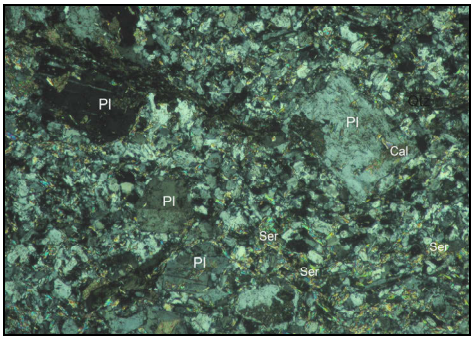

Fig. 4. The microscopical image of monzodiorite porphyric (N+), Pl-plagioclase, Cal-calcite, Ser-sericite.

The shore contains unconsolidated Quaternary deposits of glacial moraine and stream gravel. In the East of the Whittier, the shore is constituted by clay-schist and massive limestone. The metamorphic rocks have a pronounced cleavage generally perpendicular to the bedding.

3. GEOMORPHOLOGICAL SETTING

The morphological features of the Whittier area are the result of the complex geomorphological evolution in Wisconsin glacial period and are at the same time closely connected with the tectonic history of the region, continued with Holocene glacialism in present day. The glaciers are the principal agent for the modelling of relief, therefore the preeminent landforms have glacial origin. In the case of the Whittier area, there are zones of erosion, accumulation and transport by Whittier, Learnard and Billings Glaciers where there are typical features of glacial action. The climatic conditions add to these landforms, especially in summer, when the temperature is not constant, and exogenous processes affect the rocks. Slope landforms and processes can be formed by gravity, running water or cryoturbation. Stream landforms and processes are specific only in summer. The most typical features will be described below with examples from fieldwork in the Whittier area.

4. TYPES OF GLACIERS FROM PASSAGE CANAL

In the surroundings of Prince William Sound, there are a lot of glaciers concentrated around the bigger glaciers and icefields. The Columbia Glacier spreads in the northern part of sound. It is known as the largest tidewater glacier in North America. This glacier has 42 miles length and 4 miles wide at terminus and has many branches in all directions. In the eastern part of Prince William Sound, there is another big glacier, Bering Glacier, which has its origin in Bagley Icefield. In the opposite part, in the West, there are Sargent and Harding Icefields, which feed the glaciers from Kenai Peninsula.

Fig. 5. Chugach Mountains and Learnard Glacier.

In the Passage Canal there are two main types of glaciers: hanging glaciers and valley glaciers. The hanging glaciers are clung on inclination slopes, near the peaks in snow accumulation zones. This type of glacier forms if a valley or cirque glacier ends abruptly at the top of a cliff. Two good examples include Shakespeare and Lowell glaciers located in Passage Canal. After the Wisconsin Ice Age, many bigger glaciers have melted and now they are little hanging glaciers.

The valley glaciers fill the space between ridges and transfluence saddle. This type of glacier is very common throughout Alaska. In the Passage Canal, there are Billings and Learnard Glaciers that flow into the Pacific Ocean.

The icefields represent a large mass of ice where many valley glaciers flow out on all sides. A representative icefield from Whittier area is Blackstone Icefield situated in northern Kenai Peninsula and feeds Whittier Glacier, Northland Glacier, Concordia Glacier, Burns Glacier, Portage Glacier, Spencer Glacier and many other glaciers of which some reach the Passage Canal, others the Blackstone Bay or the North-West and South part of the peninsula.

Another type of glacier that exists in Passage Canal is the cirque glacier. Cirque glaciersn are formed near mountain ridges, in circular basins or amphitheaters, but they are relatively small.

5. GLACIAL LANDFORMS

The landscape is the result of climate and of latitude as well. These factors were both an advantage for the development of glaciers on the valleys. Only the high peaks are not affected by ice mass in Whittier area. The glacial cirques from the South-East of the Whittier have big circular basins and are situated at low height. The walls of these cirques are vertical and are furrowed by waterfalls. The slopes of the cirque are relatively small, but the amphitheater form is still kept. The glacial valleys, after the melting of glaciers, are modelled by creeks. Along the valleys with steep slopes there are many waterfalls, which have the nourishment from glaciers. The cross sections of young valleys show a beautiful glacial U-shape (fig. 6) which later will be influenced by gravitational phenomena and running water erosion.

Fig. 6. Glacial valley from Kenai Mountains.

Fig. 7. Hanging glacial lakes.

The glacial erosion processes created edges of overdeepened hollows, erosional scarps, cirque edges, transfluence saddle, steps of hanging troughs and smoothed surfaces. On the high platform, there are remains of hanging valleys and glacial lakes. In the vicinity of the Whittier Glacier front, on the sliding bed of ice mass there are rocks moutonnée.

The complex material of rocks resulted from glacier transport represents the constructional landforms and deposits. In Whittier area, there are superglacial moraines, moraine ridges, moraine deposits and erratic boulders which are very visible at the Learnard Glacier (fig. 8). The moraines take particular festooned forms, often arranged in sequential rows. When a glacier is still, which means it neither advances nor recedes, transported rock and debris that is always left behind at its terminus accumulates there. The result is a new landform: the terminal moraine.

6. PERIGLACIAL LANDFORMS

The cryoclastism is a physical process which changes the geomorphological modelling in Whittier area. Cryogenic and nivation landforms are included in erosion landforms – avalanche tracks – and accumulation landforms and deposits – protalus ramparts, block streams, block fields. Gelifluction phenomena give also rise to evident morphological features especially on slopes near the Shakespeare Shoulder and Portage Pass. Processes connected with ice and snow hasten the rock flows. As an example, there are rock glaciers which represent an interesting landform developed on the high and steep slopes.

7. GRAVITATIONAL LANDFORMS

Landforms and deposits due to gravity in Whittier area represent the effects of retreating glaciers. The best example are the blocks of rocks present in the valley created by Learnard Glacier. While glaciers withdrew, the pressure of walls diminishes and scree slopes, landslides and talus heaps are born. The results of wall erosion are scarp edges and rock defile with occasional debris falls. The landforms such as talus cones are accumulations of avalanche tracks and are frequently at base of walls and glacial cirque floors.

Fig. 8. Moraine deposits from Learnard Glacier.

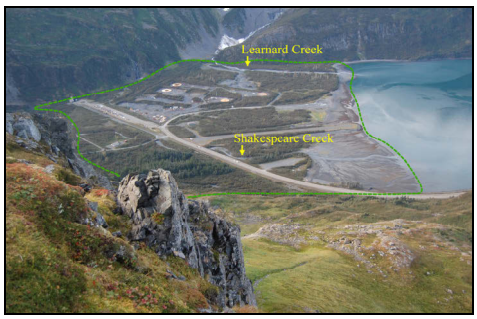

Fig. 9. Coalescing delta West of Passage Canal.

8. ACCUMULATION LANDFORMS AND DEPOSITS DUE TO RUNNING WATER

After the retreat of the glaciers, by the ocean, the torrents dropped the sediments and constructed deltas at the margins of fjords. In Whittier area, there are three lowlands which represent unconsolidated Quaternary deposits, consisting of glacial moraine, coarse sands, reworked outwash and stream gravel. The large sheet of glacial gravels is the most recent deposit of the region - a result of prevalent fluvial processes.

Whittier is built on a fan-shaped delta formed by extensive deposits of fluvioglacial gravels. This material is a result of the Whittier Creek contribution – a creek fed by Whittier Glacier. In the western part of the Passage Canal, there is a lowland area which consists of coalescing deltas of creeks flowing from Portage Pass, Shakespeare Glacier and Learnard Glacier. Another large delta was formed by Billings Creek on the north side of the Passage Canal.

9. ANTHROPOGENIC LANDFORMS AND DEPOSITS

The heavely shaped area includes human establishments and neighbourhood of harbours. Few of these are found in Whittier area and are situated on the shore. The artificial landforms were born in the same time with the improvement of territory. On the dry land, artificial debris are used for building the parking lots, the track for planes and roads. For railway improvement, it was necessary to modify the slope and the result was vertical walls and edge of excavation. On the wetland, people built embankments and near the shore they stabilized the cliff with blocks of rocks.

The human factor influenced the landscape modifying the topographic aspects. Thus, construction of buildings and streets imply equalization of ground and creation of embankments, improvement of tunnels, while plumbing and sewerage networks involve diggings and storage of materials.

10. CONCLUSIONS

The geology of Whittier belongs to Kenai and Chugach orogen and it contains those three groups of rocks because of intricacy of forming conditions. In Whittier area the sedimendary rocks are represented by graywakes and sandstones. The magmatic rocks associated with subduction zones are present in the continental arc type structures

through monzodiorite. The metamorphic rocks originate in the continental lithosphere affected by cutting during accretion prism formation. The sample rocks analyzed present local and allochthonous character, due to the fact that two rocks taken from the same place have affiliation to different groups.

All landforms of the Whittier area are the result of endogenous and exogenous processes, molded by ice which eventually created the famous fjord system included in the Prince William Sound.

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