

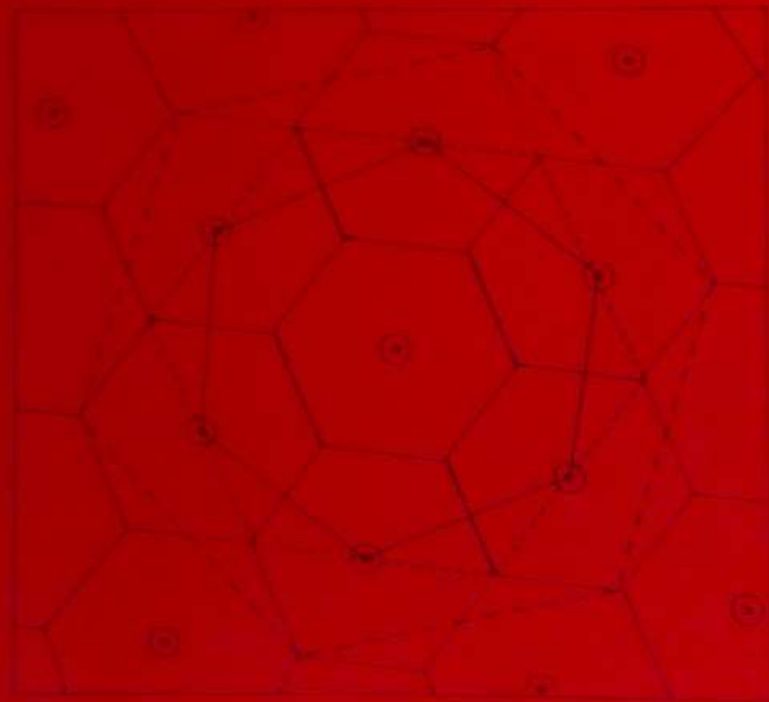
# GLACIAL DEPOSITS

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## GLACIAL DEPOSITS



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## **A Geologist's Travels in Chile**

by Richard Harwood

The Andes Mountains. These three words invoke a wide variety of responses depending on who reads them. For many, pictures from a recent issue of the National Geographic Magazine come to mind. Stories of the ancient Incas and Spanish conquest and pillage come to mind for others. To a geologist, the Andes represents one of those premier geological locations on the globe. It is touted as the type example of an ocean-continent collision when talking about Plate Tectonics. A continent-spanning coastal mountain range, dominated by a chain of stratovolcanoes is often how we describe it to our students. We point to it on maps, show pictures of it, mention it in lectures on everything from Plate Tectonics, to mountain building, to volcanoes. Additionally, a lot of arm waving is often associated with this topic in an attempt to convey the size and importance of this one mountain belt to the science of Geology. And yet, how many of us can claim to have actually seen this "premier" piece of geologic real estate?

I was fortunate enough, this past November, to be able to spend a total of three weeks in South America, with most of that time spent in the country of Chile. I went there with a study group organized by the Smithsonian Institution, but stayed in country even after the rest of the group had returned to the United States. The extra time in Chile and the time spent with the study group allowed me to visit a number of locations in the Andes from points south in Tierra del Fuego, to points north in the Atacama Desert. The purpose of this essay is to try and convey to you some of the geologic settings that were seen and to present some thoughts on the Andes. And hopefully, somewhere along the way this will convince you that a trip to South America is worth taking, if for no other reason than to be able to say you've seen it.

Four main locations were visited during my stay in South America: Tierra del Fuego, Torres del Paine National Park, the Cajon de Maipo, and the Atacama Desert. Each was unique in its scenery and geology, but all had the common theme of being part of the Andes Mountains.

Tierra del Fuego is a large island shared by both Argentina and Chile, and marks the southern end of the Andes. The dominant features here are the present day glaciers, glacially eroded terrain and fjords. Access to many of these areas is only accomplished by ships cruising the narrow fjords. Tide water glaciers, valley glaciers, hanging glaciers, reconstituted glaciers and the Darwin Ice Sheet are all visible in various locations. Spectacular melt-water falls compete for attention with U-shaped valleys, moraines, small blue-colored icebergs, and a variety of marine and avian life.

Torres del Paine National Park is located north of the Strait of Magellan on the eastern edge of the Andes in the Chilean Patagonia. Of the places visited, this was by far the most spectacular. The main feature of the park is a 12 million-year-old, white-colored granitic laccolith which was intruded into Cretaceous shales and sandstones. Contact metamorphism then altered the sedimentary rocks into black-colored hornfels.



Author Richard Harwood took these photographs near the southern terminus of his excellent Andes Adventure. Left Numerous glaciers come down to salt water on the Chilean side of Tierra del Fuego (Land of Fire). Here is one example at Brooks Bay. Note how rotten the ice in the glacier looks in November, the southern hemisphere's equivalent of our May. Below Spectacular evidence of alpine glaciation dominates this view of the Chilean Andes in Torres del Paine National Park, located north of Tierra del Fuego.



All of this has been dissected by Pleistocene-Holocene glaciation, exposing the laccolith and the sharp color contrast between the granite and hornfels. The surrounding, unaltered sedimentary rocks are faulted and folded, and have been intruded by numerous basaltic dikes. Add to this setting active glaciation of the South Patagonia Icefield, strong winds, constantly changing weather, and an abundance of wildlife in the form of guanacos (cameloids) and condors, and the result is simply spectacular.

Cajon de Maipo is a large canyon located southeast of Santiago. It is a popular recreational area for the residents of the capitol on summer weekends. The canyon cuts through Miocene and younger ignimbrites and flows, while the higher ground is dominated by the more recent volcanic centers, such as the Maipo Volcano located further to the southeast.

The Atacama Desert in northern Chile, in the area of San Pedro de Atacama was also visited. The Atacama Desert is described as a hyper-desert, due to extremely low amounts of precipitation that are the result of its high elevation, the rain-shadow effect of the Andes and the development of the cold Humboldt Current along the Pacific coast. The area is geologically characterized by structural depressions, faulting, folding, salt lakes and salt flats, extensive rock salt deposits, active hot springs and geysers, and the high elevation peaks of the central Andean volcanic chain and associated deposits and flows. While not as visually spectacular as Torres del Paine, it was geologically the most diverse area visited and was amazing in its own way.

If I had to pick one area, of those areas that I visited, that I would visit again, it would have to be Torres del Paine National Park. The Atacama Desert is a close second. But with so many other part of the continent yet to be visited, it is hard to say where I will go next.

My trip to South America highlighted a number of differences in my prior perception of the Andes and the reality of the Andes. Everyone who has taught Geology or read articles in Geology has built up a perception of the Andes based on what has been taught to us or what we have read. A volcanic arc, formed by the subduction of the Nazca and Pacific plates beneath the western margin of the South American continent doesn't begin to do it any real justice. After having been there, I can appreciate the difficulty in trying to convey the enormity, diversity, scope and complexity of the Andes – and I only visited a small portion of it. I am by no means an expert on Andean volcanology or tectonics, but it is obvious, even from a brief visit, that there is more going on geologically in the Andes than many of us are fully aware.

One of the misperceptions that is common in regards to the Andes is that it is primarily a very large volcanic chain. The volcanoes do make up an important and major aspect of the mountain range today and even during the period when South America was still part of Gondwana. Many areas of the Andes are dominated by plutonic intrusions. Intrusions that were formed during much earlier subduction-related volcanism. Older volcanic layers and formations also attest to the importance and long-term influence that volcanism has had on the cordillera. But while volcanism has been a

major mountain building force in the Andes, the other main aspect of the Andes that is often overlooked in introductory-level descriptions are the tectonic influences.

Evidence of the tectonic and structural aspects were clearly evident in the areas that I visited, but also are found in areas like the Cordillera Blanca, the Altiplano, the Junin-Huancayo Basins and the Sierra Pampeanas to name a few. The Cordillera Blanca is a Miocene-Pliocene batholith that has been tectonically uplifted. The Altiplano is the second most extensive high plateau in the world (the Tibetan Plateau is first). It is believed to have formed as a result of crustal thickening resulting from crustal shortening and uplift. The Junin-Huancayo Basins is a series of graben structures flanked by the raised eastern and western cordillera in Peru. Lastly, the Sierra Pampeanas is composed of Precambrian and Paleozoic aged rocks uplifted along a series of reverse faults in Bolivia. These examples are all from the central Andes. Extensive and complex deformation of the crust is seen throughout the Andes. The areas that I visited showed ample evidence of this tectonic history and in some case overshadowed the volcanic or glacial features.

To conclude, there are two points that I would like to emphasize. The first is that the Andes Mountains are much more complex than many of us may realize. I count myself amongst those that tended to over-simplify the Andes. Upon closer examination, the simple Plate Tectonic model of an ocean-continent convergence boundary isn't as simple as it appears. The Cascade Range in North America and the volcanic chain in Central America more closely match this simple view.

The second point, and in some way the more important point, is that the Andes are SPECTACULAR!! Whether you are a geologist, geographer or tourist, go see them if you get the chance – you won't be disappointed.

*EDITORS'S NOTE: **Richard Harwood** professes Geology at Black Hawk College in Moline, Illinois. He has attended all seven of the two-year college teacher conferences we have hosted here on or near Veteran's Day.*



Some deserts do resemble the surface of Earth's only moon. Here, in northern Chile, Richard Harwood looked out over a lunar landscape. Valle de la Luna (Valley of the Moon), in the Atacama Desert. Note the snowcapped Andes in the distance.

**Citation**

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