



Surface Forms in Western South America

Author(s): C. Reginald Enock

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opinion may be formed as to the correctness of his conclusion. In doing this it is not necessary to cite any of his collateral achievements.

WILLIAM HUNTER WORKMAN.

Lucknow, March 31, 1908.

Surface Forms in Western South America.

Northwood, Middlesex, April 20, 1908.

In the April *Journal* appears some interesting matter relative to snow-formations, or *nieve penitente*, also sand-dunes. The west side of South America offers—especially in Peru—an exceptionally interesting field for the observance of desert and mountain phenomena, especially those induced by æolian action and peculiar climatic conditions. As regards the pillars, or *penitentes*, as they have been fancifully termed, they are not confined to snow, but in the foothills of the western Andine desert region are to be seen in earth, and might be called *tierras penitentes* with equal reason.* I have observed singular pillars of this nature here, generally consisting of a tapering cone of soil capped at the top by a large pebble, or even a rock. I have also noted similar but much smaller structures on the plateau of Anahuac, Mexico. The surrounding level has, of course, been worn down by the action of wind, sun, and rain (although parts of these regions are rainless); the stone forming a sheltering and consolidating covering. In the Chilean Andes of Tarapacá there exists in a certain place some remarkable series of pillars of earthy mud, formed by disintegrated rock. These strange pillars, which look like groups of statuary, often are of 10 to 30 feet in height, formed of material impregnated with sulphate of lime. During the day and under the heat of the sun they become soft and with a muddy-appearing surface, but at night become exceedingly hard, like frozen mud—the effect of temperature upon the sulphate of lime which they contain. The elevation is more than 14,000 feet. In the Peruvian Andes very remarkable gravel and conglomerate pillars are encountered at high elevations of the most weird forms, also due in some cases to action brought about by mineral impregnation.

A word as to sand-dunes. The coast plains of Peru and Northern Chile form an absolutely rainless region, and here æolian action plays strange pranks with the fine drifting sand. I have observed the singular *médanos*, or travelling crescent-shaped dunes, here in a most perfect form, especially near Camaná and on the deserts west of Arequipa. I made careful observations of some of these dunes, with measurements, but at the moment have not my notebook at hand. I observed an “army” of hundreds of them in their slow movement across the plain. Of course, the movement is not visible without close observation, and depends upon the force of the wind. It might amount to 1 or 2 feet in an hour when the breeze blows briskly. On the sea verge I observed them being “born”; that is, they evolved out of a bank of fine dry sand, took their characteristic crescent form on a flat upper beach, and were strung out away inland, all of similar shape and proportion, but of varying sizes. The æolian ripples on their backs—which, of course, is the cause of movement by the constant changing of place of the particles—reminded me of the quivering of the skin of an animal. I have spoken of these dunes and the region generally in a recent book—the ‘Andes and the Amazon.’

C. REGINALD ENOCK.

* The parallelism between the *penitentes* and the well-known earth-pyramids has also been suggested by Dr. S. Günther (cf. *Journal*, vol. 26, p. 91).