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Dr. Güssfeldt's Work in the Andes

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after frequently cutting a way through forests and fording streams. Standing on the Susu Hill (about 4000 feet above sea-level), nothing could be seen but interminable forest-covered elevations, and it was ascertained from the natives that the most arduous 15 or 20 days' travel remained before a white man could be reached. Von Schaumann, who died on the voyage home, was still hopelessly ill, the only other officer was in a deathly stupor from sunstroke (he eventually recovered), and the leader was covered with painful ulcers, much emaciated, and with bleeding feet; nevertheless, he made an attempt to push on by himself for help, and four days afterwards, when on the point of succumbing, met with a native sent on by M. Van de Velde, who had been despatched by Mr. Stanley to succour the party, and was still seven days off at Kilabi (since formed into a station called Taunton-ville). Captain Elliott and his two companions succeeded in reaching the coast, having travelled 600 miles in $3\frac{1}{2}$ months; and he has subsequently thoroughly explored the Kwilu-Niadi river and valley with Mr. Spencer-Burns and MM. Mikic and Destrain.

The district has for the most part been freely ceded by the natives to the Association, and formed into a province, in which there are 15 stations, under Captain Elliott as administrator, with a staff of 28 officers and about 250 men.

Dr. Güssfeldt's Work in the Andes.

THE results of Dr. Paul Güssfeldt's journey in the central Chilian-Argentine Andes have recently been communicated to the Berlin Academy of Sciences, and we are indebted to the courtesy of the traveller for an early separate copy of his preliminary account. His explorations extended from November 1882 to March 1883, in the wild and lofty mountain region containing Aconcagua, the most elevated known point of the American continent, which lies between 32° and 35° S. lat., and is limited on the east by the Argentine Pampas and on the west by the Pacific. For scientific purposes, this was practically a pioneer journey, as the country is only known in its lower elevations, or along narrow cross mule tracts. Already trained for mountaineering by his experiences in the European Alps, and to the use of scientific instruments during his journeys in Northern and Equatorial Africa, Dr. Güssfeldt set himself the daily general task of observing the great orographical and landscape features, the glacial conditions above the snow-line, the character of the vegetation, and the phenomena of rock weathering; as well as the special duty of fixing positions astronomically and taking altitudes, for which purposes he was provided with nineteen instruments of various approved kinds. The central Chilian-Argentine Andes,

which are peculiarly adapted for showing the influence of climatic and meteorological factors in the modification of surface features, are sketched by Dr. Güssfeldt as two parallel chains, having on the Pacific side an outlying coast range. The western chain is the true water-parting of the Atlantic and Pacific, and the eastern is in many places broken through by the waters rising in the great trough between the two chains, which has no well-defined valley formation, indications of a longitudinal depression being only found at intervals, constantly interrupted by cross ridges. This trough or basin is of the highest orographical interest, and affords a problem yet to be solved. It is about 185 miles in length, entirely uninhabited, with a mean elevation probably over 9800 feet, only in a few places crossed by mule paths; and presenting such difficulties of travel in its axial direction as trained mountaineers could scarcely cope with, but which must still be overcome by the indispensable mule caravans; to these impediments, it must be added that even scattered localities where food could be obtained are unknown, and that three months of the year at most are available for exploration. For a thorough exploration of this region, Dr. Güssfeldt is of opinion that the native guides, though very serviceable, are not enough; without Alpine guides from Europe, the traveller is like a man in fetters, and it is only as an exception that he can reach the panoramic summits affording views essential to his undertaking. From his remarks it is clear that care must be taken in the selection of even experienced Swiss guides for this work (Mr. E. Whymper's success, however, has proved that thoroughly efficient men can be obtained). The outer flanks are equally complicated; and a very characteristic feature in the structure of the chief valleys is indicated by the term "cajon" (box or chest) applied to them, instead of the usual word "valle"; each is, as it were, a basin with straight sides, having a separate vegetation-zone, limited by perpetual ice. These valley sides are composed of boulder slopes and wall-like outcropping rock, the latter generally showing distinct traces of stratification or bench formation, presenting the appearance of projecting and almost horizontal bands, thrown in relief by their differences of colour. The diversity and richness of the tints of soil and rock are indeed material points in the landscape, as the vegetation, in some places of great luxuriance, is as a whole of irregular distribution, to such an extent that belts and not lines of the flora are capable of definition. The snow limit is also not to be rigidly fixed, and for the like reason, the number of factors and local influences.

At the four points where Dr. Güssfeldt crossed the divide, he obtained the following altitudes:—Atravieso de la Leña, 13,474 feet, Paso del Maipo, 11,394 feet, Cumbre Iglesia, 12,303 feet (on the Uspallata road), and Boquete del Valle Hermoso, 11,696 feet: the crest-line between these elevations was estimated to reach over 19,600 feet. The passes of the second chain reach similar heights (13,779 feet, 12,270 feet, and

9494 feet). The highest elevations are in the neighbourhood of Valle Hermoso, not on either the eastern or western main cordillera, but apparently on lateral spurs of the chief western chain. The mountain land forming the left northern side of Valle Hermoso comprises the Ramada range, with peaks 19,685 feet, the highest being 21,040 feet. Finally, the great volcano Aconcagua reaches 22,867 feet near the commencement of Valle Hermoso.

The glacial covering of the central Chilian-Argentine Andes is as a whole widely different from the Alpine type. This is perhaps to be referred less to quantity of deposit, than to the structure of the highest points, which is unfavourable for the collection of large glacier-forming masses of snow. The wind also doubtless plays an important part in carrying off the fallen snow; at all events, the north-west side of Aconcagua is entirely free for a belt between 19,685 to 21,653 feet, although it is there of a trough-like construction, affording good hold. Elsewhere, the conditions of position and incline favourable for retention of ice are markedly wanting; and the channels capable of holding extensive glaciers are either climatically too low, or, if high enough, too steeply inclined. The snow-line is often broken by abrupt ice streams wedged between masses of rock, which terminate far above the valley bottom; and even where sufficiently broad channels communicate with a slope covered with perpetual snow, the descending ice disappears before reaching the base. Dr. Güssfeldt discovered, however, one ice-stream which appears to form a remarkable exception to the general poverty of the chain in this respect. The head of a side-valley of the Cachapual, called the Cajon de los Cipreses, is filled by a magnificent glacier (named the Ada glacier) nearly 12 miles in length. The ice has its source in a vast snow basin some 10 miles in length, fed by numerous secondary glaciers, and surrounded by lofty peaks, of which the Gran Onorado, 14,816 feet, is the highest. It escapes from this in an icefall, 8530 feet in length, and of an average slope of $22^{\circ} 15'$. Below the fall, the tongue of the glacier pushes down the valley for 4265 feet more with a slope of $12^{\circ} 45'$ ending (in December 1882) at the height of 6299 feet in a cavern, the source of the stream. There is evidence in the glaciation of the rocks below the present extremity of the glacier, that it once reached a far lower level. A cliff now more than 6000 yards distant from the glacier is covered with glacier marks; and Dr. Güssfeldt's companion pointed out a conspicuous red boulder as marking the point reached by the ice thirty years ago, and which is 5676 feet distant from the present glacier.

The highest peaks but rarely show a continuous snow-cap, as the common formation of abrupt crags leaves the naked rock almost everywhere exposed. Crevassed snow-fields and broken glaciers are thus common phenomena; and Dr. Güssfeldt especially notices some peculiar formations of the upper snow locally called "Penitentes" or pilgrims, most curious

ice-figures, modelled as it were by exposure to a fierce sun out of the ridges thrown up between parallel furrows caused by strong winds blowing on the surface. These figures are sometimes so high that a horseman is hidden between them as if by the tall grass of an African savanna. They were seen in different stages, and were most strongly developed at the bottoms of high snow valleys, in a zone of from 11,483 to 13,779 feet, but also occurred on unfurrowed snow-slopes. As regards the snow-line, its mean is estimated at 13,779 feet, between 32° and 33° S. lat.; 11,483 feet in 34° S. lat.; and 13,123 feet 10' further south; it is beyond question much lower between 32° and 35° than in other parts of the Andes.

Dr. Güssfeldt's tables of astronomical positions, barometrical readings, trigonometrical and magnetic observations, &c., which are numerous, are not capable of condensation: a special section is devoted to the mensuration of Aconcagua, the highest peak of which is given as situated in 69° 59' 5" W. long. and 32° 39' S. lat., and as being 22,867 feet above sea-level. He discusses the question of the effect of rarefied air upon the human frame at great elevations, and from his own experiences is much of the same opinion as that expressed by Mr. Graham during his recent account of his Himálayan work. He and his assistant attained 21,030 feet on Aconcagua, and were able to work their scientific instruments at that height, though not in good condition from anxiety and want of sleep; their lungs were physically exhausted by the effort of speaking, but there was no flow of blood from nose or ears. He says that the so-called "Puna" can be resisted by mental effort and confidence, the only effects upon a properly trained individual being those of increased lung-action, and that any one who could work as he did at 21,030 feet could reach the top of Aconcagua, where the proportion of oxygen is only 6½ per cent. less than at that elevation.

The numerous plants collected are briefly analysed by Prof. Ascherson; the minerals (which establish the volcanic nature of Aconcagua) are to be separately treated by Herr Justus Roth.

GEOGRAPHICAL NOTES.

Lieut. Shufeldt's Explorations in Madagascar.—Lieut. Shufeldt, of the United States Navy, has recently made an important journey across the island of Madagascar in a direction south-west of the capital not previously explored by a scientific traveller. Leaving Antananarivo with a large party, he made for the sources and numerous tributary head-waters of the Zizibongy river, which he thoroughly investigated and mapped, and in descending the plateaux to the south-west coast made accurate observations of the successive escarpments. He travelled