a depth of 590 feet. This is three times the depth of the Arctic minimum. The difference is due to the vast mass of the Antarctic icebergs in comparison with the Arctic hummocks.

Below this cold stratum to a depth of about 6,500 feet, extends a stratum of water warmer than 32 deg. F., having a uniform salinity of 3.46 per cent. The same salinity is found at still greater depths, but the temperature gradually diminishes to 31.3 deg. F.

We find here, then, a warm stratum between two cold strata, as in the Arctic. The upper cold stratum is evidently moving northward, while the warmer but

denser intermediate stratum consists of water flowing southward from warmer regions. The force deduced from the distribution of salinity and density at the surface is directed northward, but the prevailing winds, aided by the effect of the earth's rotation, deflect the surface current toward the west. This current is finally merged in the eastward current which marks the limit of the Antarctic circulation, at about 50 deg. S. lat. The density of the surface water diminishes in going either northward or southward from this line.

The Antarctic ice is partly marine and partly terrestrial. Some of the colossal icebergs are composed

chiefly of blue ice formed along the shore. Antarctic icebergs are seldom encountered north of latitude 45, but in 1894 the remnants of one were seen in 26½ deg. S. lat.

Our knowledge of the polar seas will almost certainly be improved in a few years. A ship drifting with the ice is in the best possible condition for observing the physics of the sea. The expedition headed by Roald Amundsen will start from Bering Strait in the autumn of 1911, equipped with the most improved oceanographic apparatus. The plan is to cross the Arctic basin as near the pole as possible. Antarctic expeditions are also projected.

Characteristic Features of Rocky Deserts

Relation of Protective Crust to Ravine Formation

By Dr. H. Burmester

In every rocky desert are found two distinctive features which form characteristic phenomena of the wide, barren landscape beaten upon by the fierce sun of the sub-tropics: the so-called tropic protective crust and the intricately winding dry valleys with smooth, steep sides known as wadis.

These phenomena have hitherto been regarded as separate and dissociated in cause, but recent investigations have clearly demonstrated their close connection and interdependence.

The term "tropic protective crust" is used to designate the thin hard coating found upon all desert rocks. This coating, due to the intense dry heat, consists of a layer of iron and manganese oxide. It may be distinguished from the rock itself by scratching with a sharp instrument.

According to the investigations of Mr. J. Walther, a yellow color shows a newly formed crust containing a hydrated iron oxide, a red color shows an older crust which has been changed into iron oxide by loss of water, and a gray tint shows the presence of manganese oxide.

The colors of the crust vary between deep black, clear gray, and all shades of brown, which generally shows the presence of silicic acid, the darker the stone the richer being the crust in this acid.

The second marked phenomenon of these deserts are the ravines cut deep in the horizontal plateaus, inclosed by lofty, unscalable walls, and often ending in a steep blind wall after long extents, measured by journeys of hours or even days.

The desert east of the Nile valley, beginning near Cairo, is a characteristic rocky desert and affords an admirable as well as accessible field of observation.

1. INVESTIGATION OF EFFECT OF PROTECTIVE CRUST ON INTENSITY OF EROSION.

In the desert a distinct difference is to be noted between stone exposed to direct sun and that which receives little or no sunshine.

The first is covered with a crust which is harder than the mother stone, and is severely eroded on the surface, to which fact is due the name tropic protective crust.

This crust or rind is formed wherever direct sun rays fall, but also creeps into tiny superficial cracks into which no rays penetrate. It would thus seem to be due to the heating of the stone, which favors a chemical combination of the stone with the iron and manganese salts of the atmosphere.

Those portions of the stone lying in shadow, on the other hand, are not protected by a crust against superficial erosion. Hence the moisture of the night dew or an occasional rain remains longer and chemical erosion proceeds unhindered.

Erosion therefore begins in the shadowed part forming tiny cracks or projections which gradually increase inward until a cavity is formed in the side or top, or the projecting portion, eaten away from beneath, falls of its own weight.

This is called erosion from within outwards. When a large piece of rock forming such a projection breaks off, a protective crust is at once formed on the exposed surface of the breach. The fallen block lying on the ground shows the protective crust on every side, but betrays inner cavities which have eroded outward so as to break through the crust, in which case the crust extends in patches from the roof of the cavity.

The pendent parts shadow the bottom of the cavities formed by them and therefore accelerate the erosion. But these fragments and projections owe their existence to the protective crust since this preserves them from too rapid decay.

Often, indeed, the mother stone is entirely eroded, and only the harder crust still hangs to the rock as the roof or sidewall of a cavity.

Thus we see that the term "protective" crust is accurate only in that the stone immediately underlying it is protected. On the contrary, the crust favors the shade erosion which is the dominating factor in the desert, since through its greater hardness and durability it allows such shadow-making portions of the rock as the roofs or walls of caves to stand longer than they otherwise would.

Since the crust favors the dominant cause concerned in the characteristic rock forms of the desert, by logical deduction it must be a significant factor in the formation of the wadis.

It is not, however, here implied that the crust is a necessary feature of erosion, since crusted and non-eroded rocks are found.

In order to discover whether there was a "weather side" in the desert, I examined Egyptian architecture.

In the desert itself there are too many factors concerned for a definite result to be reached. The direction of the wind and the hardness of the stone are determining factors, and moreover it is difficult to find a block of an undoubtedly synchronous breach and yet of a different orientation.

But it is a well-known fact that the stones employed in Egyptian buildings show crusts after 6,000 years.

One of the best known examples of this is the dam discovered by Schweinfurth in the Wadi Geraui at Heluan. The blocks used there, which have an eastern exposure, are only slightly attacked on top and show a marked brownness; yet a distinct cavity is eroded in the soft gypsum of every stone.

For our purpose, however, the pyramids offer the best example, being exposed to every point of the compass. Of the pyramids at Ghiseh only the Chefren still shows a portion of the original covering near the summit. The others show only eroded blocks, the time of whose exposure is undiscoverable.

All four sides of the Chepen pyramid have an equally brown tint, showing an equal amount of erosion. The vertical summer sun, therefore, has strength enough to develop the crust even on the north side.

This facilitates the study of the wadis, since in investigating the crust erosion the orientation of the rocks may be disregarded without its becoming a serious source of error.

If we look at the Sphinx we observe that on the back of the head there is a strongly marked crust and obvious erosion has begun, while on the eastward-looking face there is little crust and little erosion. It seems to remain true that where there is little crust there is little erosion.

A special form of the crust is here referred to, in which on normal brown-crusted rock a slag-like applied crust appears in spots. This is black and always raised in relief. If such a stone is cut in sections there is usually found lying under these accretions darker stone containing lumps and hollows, or else arranged in layers. The hardness tests show it to consist of hornstone injections in chalk, which explains the dark color, since this gains in darkness as it gains in silicic acid. It is not unusual for hornstone to be found in localities where fossilized wood is often found. In any case we see that harder stone raised in relief lies opposite crust-covered chalk.

When the chalk weathers its protective crust does not completely resist the outer erosion, but renews itself constantly much like the human skin without showing definite flaking.

In this process of renewal it takes material from the mother stone and occasions therefore a steady erosion from without inward.

This erosion, which is naturally very slow, proceeds side by side with the much more rapid and important shadow erosion.

The crust does not always work continuously into the rock. There are cases in which the crust breaks loose from the rock in layers—the process of desquamation. In such instances the action is ascribed to solutions of salt which have filtered in and then crystallized. . . .

WADIS.

The extensive course of all wadis suggests water as the creative agent. The question is whether the quantity of water now available is sufficient to have caused them or whether a greater precipitation formerly existed.

For the Sinai desert a pluvial period seems indicated. Hume concludes from marked boulder and pebble deposits that great snow fields existed in former ages. He considers it certain for Sinai that now in the pebble deposits of the wadi mouths the denudation exceeds the deposit, and that therefore smaller streams now dig their beds in the pebble deposits washed down by former mighty floods.

Direct conclusions as to the Nile valley cannot be drawn from this, but close observation of wadi formation gives various indications that water erosion has had a share in modeling the relief of the desert, and that to a greater extent formerly than now.

Take the Wadi Hof, for example. It is at once obvious that we find ourselves in a valley where water has been active. The ground consists of rounded grains of sand. If there are contiguous walls we find definite water erosion grooves, with clearly defined wave marks. Here we find white eroded channels. Yonder we find

heaped-up piles of rubbish.

Now let us direct our gaze to a bank of hard chalk over which erosive masses of water have undoubtedly plowed when some rare rainfall has sent down its revivifying floods. On this bank we find at spots where the water must flow with slight force light traces of crust, while wherever the water has dry furrows with violent deluges not the slightest remnant of the brown crust remains.

Thus we see that in many places the water has gained the victory, in others the crust has won the day.

In order to study better this conflict between crust and water I investigated the chalk banks in the branch wadis leading off from the main wadi, since there in all probability the crust action would be greater because of the smaller quantities of water.

This conjecture was verified, for without exception the ground of the branch wadis showed, wherever hard chalk banks were present, dark crust above earlier erosion marks.

In the foregoing I have sought to present a series of erosion phenomena which give an impression that the condition of the desert valleys of the localities considered cannot have been caused by such quantities of water as exist at present.

The conflict between the water and the crust gave us the clue, and showed how in the branch wadis the crust formation had the upper hand, while only in the main ravines could sufficient amounts of water collect to effectually oppose the crust formation.

This struggle was active when mighty floods still rushed through the valleys; but slowly the waters diminished and the crust won the upper hand.

The eroded chalk banks show positively that to-day the crust action is greater in extent than water erosion, for the bed worn by the rain water occupies only a small part of the whole width of the wadi. Moreover, those parts of the broken stone coated with the brown crust are not partially washed away again as we saw them in the main wadis.

If we observe upon a flat surface the formation of a wadi, we are struck by the long crooked strips of vegetation which lead to small depressions and mark the course of the wadi. It is in these channels that the water runs when it rains, forming pools and occasioning the growth of vegetation.

The roots of these plants preserve the moisture longer, and therefore give rise to more rapid erosion in their neighborhood than in dry localities, and thus assist the destructive action of chemical agencies later. At some point a projection is formed, cavities begin to be enlarged, and we have the commencement of a wadi.

The essential thing is, in my opinion, the co-operative action of vegetation and water, which loosens or disintegrates long strips of the desert and makes them more susceptible to subterranean erosion later.

That water is present in the sub-soil of the wadis is proved by the cisterns which are always found in the course of the valleys. But their excavation is continued at the present day essentially by crust erosion and the formation of projections.

But the apparent conclusion that no valleys of long extent can now be formed without kettle-shaped cavities is not justified. Let us examine more closely the erosion in the wadis. We know that huge blocks fall through being hollowed out and help to widen the wadi, their fragments forming the rubbish of the sloping sides. On the one hand cavities will be formed, on the other the valley will be cut back. But since in the backward lengthening process of the wadi the stone is prepared for subsequent weathering by the influence of vegetation and subterranean erosion the progress of the wadi in this direction will be considerably more rapid.—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from *Globus*.

Excavations in the Ruins of Abasside Palace

ARCHAEOLOGICAL work of some interest was carried out by an expedition sent to Turkey from France and headed by M. Henry Viollet. He made excavations with the permission of the Turkish government in the ruins of the celebrated Abasside palace at Simara dating from the first half of the ninth century of our era. It is a unique specimen of the architecture of this period which is still very obscure. The present palace was the residence of the Arab caliphs who had been expelled from Bagdad for a certain period on account of military seditions. The archaeologist has now returned to Paris and made a report to the Academy on the subject.