For the chlorine of the chlorides, lead and silver have the strongest affinity, and these metals will consequently be often found in the upper zone as chlorides.

The decomposition above water-level of gold- and silver-bearing deposits facilitates the extraction of these metals. Metallic gold can be extracted by simple processes of mechanical concentration and amalgamation from oxidized material, while gold in undecomposed sulphides, &c., must be roasted, smelted, or chlorinated with more or less cost and difficulty. Silver likewise occurs, as a rule, in this upper decomposed zone in the form of easily amalgamated combinations (free-milling ores), while the refractory ores of deeper zones are much harder to treat.

It is doubtless for these reasons that mining enterprises often come into very critical conditions when they reach water-level, and many mines even cease to be profitable. An important part, no doubt, is played by other causes, such as the necessity of hoisting increased quantities of water, the cost of the required machinery, &c.

It is remarkable that in western North America the ground-water level lies deeper than is generally the case in Europe. The reason may be, that the present area of the interior basin of North America, which has no surface-drainage to the ocean, was formerly cut by deep valleys of erosion, which made a deeper escape of the ground-water possible. This suggestion is confirmed by the level valleys of Utah and Nevada, several miles wide and filled with very recent sediments, between comparatively narrow mountain ranges, which seem to be, so to speak, the tops only of the former ranges.

In Europe, the upper zones of the ore-deposits were worked out long ago, at a time when the science of chemistry was in its infancy. But we know from the remnants in these workings that chlorides, lead and silver carbonates, and various sulphates, such as anglesite, occurred in them, though they were not recognised. In Transylvania the decomposed products of the outcrop-zone were called *bräunen* ("browns"), with evident reference to the brown hydrated ferric oxide. The well-known maxim of the German miners concerning the "iron hat" is very ancient; and the same may be said of the Cornish proverb, "Gossan rides a high horse." Limonite is certainly a characteristic indication of the outcrop of an ore-deposit; and no doubt its reddish-brown colour has chiefly suggested the South American miners' names, *pacos* and *colorados*.

In a few instances the "iron hat" has been actually mined as an iron-ore. As a rule, it is the decomposed, porous, and honeycombed vein-material of the upper zone, and is coloured only with limonite. The part of the ore-deposit above water-level has a characteristic appearance. Quartz and other refractory gangue minerals are surrendered and impregnated by earthy limonite masses. As a rule the original texture of the deposit has become obscure: and sometimes fragments of the mineral crusts, broken off and crushed through changes of volume, are found chaotically thrown together. Occasionally, however, the original structure may still be traced in the decomposition products of the several crusts, unaltered nuclei of the ore being discoverable in them. Some substances (especially calamine formed from zinc-blende) display the stalactitic forms characteristic of the vadose region. Original druses as well as recently formed cavities are filled with new material; and in this way a secondary crustification may occur. There are some observations according to which gold has been precipitated chemically in hysteromorphous deposits. Oscar Lieber, F. A. Genth, and A. R. C. Selwyn expressed the opinion that detrital gold generally, or a portion of it, has been deposited from solutions. Laur, J. A. Phillips, Wilkinson, Newberry, Daintree, Skey, Egleston, &c., have accepted this view as more or less generally applicable. E. Cohen has undertaken to examine it critically, and is inclined by his own experience in South Africa "to adopt the conclusion reached by Devereux for the Black Hills of Dakota, and to assume that by far the largest part of the detrital gold has been liberated by the mechanical destruction of older deposits, and has been mechanically laid down; while, on the other hand, a precipitation from solutions undoubtedly takes place, but plays a very subordinate part only."

My own opinion on the subject is expressed in the above quotation. No doubt here and there, in the detrital deposits, traces of chemical activity are discoverable; but they are not sufficient to weaken the evident proofs of the mechanical origin of detrital gold.

(*b.*) *Mechanical Effects.*

The mechanical effects of moving air and water, of frost and ice, are grouped under the head of erosion, and are treated at length, so far as rocks in general are concerned, in the geological text-books. We are here concerned especially with effects of this kind produced upon those portions of ore-deposits which are exposed at the surface. We notice at once that mechanical, unlike chemical effects, are confined to the surface or a very small distance below it. In general, we must assume that the chemical changes took place first, but that the progress of erosion brings both to our view at the same time.

Verchoviky, or Surface-deposits in Sitû.—Not only water and ice (glaciers), but also wind, takes part in erosion. For instance, if an ore-deposit, by reason of its greater resistance, crops out above the level of the country, the wind will continually tend to blow away the finer and lighter portions of the detrites formed by chemical processes of weathering; so that, in the course of time, there must remain of the original outcrop only the heavier portions, so far as these are not carried away by water. In fact, my observations in the Urals is that the gold-diggings of the valley, undoubtedly formed by water, extended up the slopes to points where this could not have been their origin. The gold-bearing weathering detritus is there called *nagornyje rozsypy* and *verchoviky*.

A similar feature was observed by W. C. Kerr in the auriferous deposits of North Carolina; and I have seen it in the old gold-workings of Bergreichenstein and Nesvacil, in Bohemia, where flat mountain-ridges are covered with old pits and dumps. It is impossible to consider them as diluvial terraces, for the alluvium passes over, so to say, into the solid gneissic rock, which is traversed by many quartz veins. The gold occurs concentrated in the deepest portion of the weather-detritus—that is to say, on the contact with the bed-rock—and has penetrated all the open, loosely-filled fissures in the latter.