Geology. — *The problem of the Tectites.* By Ir. R. J. VAN LIER. (Communicated by Prof. J. VERSLUYS.)

(Communicated at the meeting of April 29, 1933).

After the first publication dated 1787 from Prof. JOSEF MAYER about the Moldavites many attempts are made to unravel the origine of the tectites. After a study of many specimens I arrived to the following suggestion, which differs from the existing theories. The shape and the sculpture of the induvidual objects are explained with a desiccation-process by the sun of a colloïdal gelmass. The progress of the desiccation relies on conformable disiccating phenomenons of other colloïdal materials than hydrogels. Laboratory experiments are not taken.

The Billitonites. I accept the gel hypothesis of N. WING EASTON published in these Proceedings of 1921 in his paper "The Billitonites". For the origin of the gelmass I assume stagnant waterpools including the weathering products of the rocks in colloïdal state in company of other "Schutzcolloïde" as humicsol or tannin, which preserve the colloïdal state till the end condition of desiccation. The climate was a wet one, but changed in a dry one. The pools evaporating will get smaller and the concentration of the colloïdal mass will rise. The pools at last will retreat to the lowest parts of the surface. We get then a number of scattered pools of different sizes over the country. At last the concentration of the syrupy liquid will become so great, that the adhesion to the soil of this viscous mass will gradually be lost in accordance with the theory of J. VERSLUYS ("De capillaire werkingen in den bodem", Amsterdam 1916). The hydrated SiO_2 particles in the gelmass are much smaller than the grainparticles of the soil. On the surface of the gelmass the capillaric forces will become negative, which cause a separation especially when air and gas can penetrate to the soilsurface. And this is the case because the gelmass includes also gasses. The soil, saturated with water including the weathering products, will liberate in the ground these gasses. (Silicification of the bedrock in Billiton is rather common). By continued desiccation the center part will loose its adhesion too. The behaviour of the desiccating mass will depend from various factors partly independant (the shape of the soil surface, the quantity and height of the gelmass a.s.o.) and partly dependant from its chemical and physical properties.

First we will get a thin film on the surface of the mass. This film will be folded and can be torn by the action of the wind. On the naked surface another film will be formed, which will become strong enough to resist the action of the wind and will separate the mass from the air. The formed gasbubbles, caught by this film, will burst and their impression on the fluid-surface will be lost, but when the liquid is already viscous enough, their impression will be preserved. The surface of the mass will become crowded with bubbles and their impressions. When the height of the mass will become on some spots thin on account of the unevenness of the soilsurface, the surfacestresses will split the gelmass. Small masses with sphereoïdal forms with circular and elliptic horizontal sections are formed with a fluidal structure. Especially on the outline of the gelmass crumbling off will happen. The periphery of the gelmass hardens in higher degree than the rest of the gelmass and will counteract the shrinking forces. These parts can get longitudinal forms as cylinders, dumb-bells, pears and tears etc. When a part of the circumference of the gelbody has a shape as in fig. 1 and the contraction takes place in the direction of the arrow, the con-

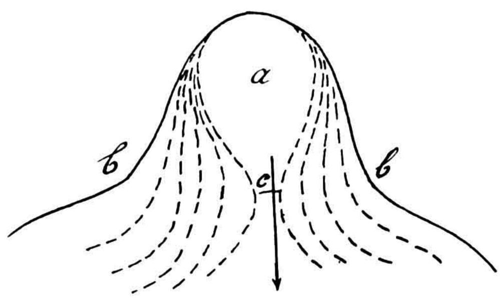

Fig. 1.

traction will be at *b* according to the dashed lines. The part *a* of the gelmass will be cut off by *c*. By this action the cicatrices of the surface will not be only stretched in the direction of the arrow, but also the gelmass within the conical part of the body *a*. A. LACROIX writes, that in tectites of Indo China the gasbubbles in the thick part of the body were spherical and stretched in the neighbourhood and direction of the point. When *a*. is cut off, the surfaces in the neighbourhood of *c* will flow together. The viscosity of the mass will determine the shape of the broken ends. When the mass is very viscous the point of separation can be drawn to a long sharp point, which will be bent after the separation by the gravitation downward, thus in the direction of the bottom part of the tectite. This is in agreement with the observations of A. LACROIX (Comptes Rendus Tome 192, 1931 N^{0}. 26 page 1687), that the tail of the tectite is bent to the side of the surface with the smallest sculpture and which is in consequence of this theory the bottom part. The dumb-bells are formed when besides the neck at *b* a second weak point arises, where the object is cut off, (fig. 2). When the mass is liquid enough the point of section will be contracted to a round shape.

We have to examine now the liquid drops more in detail. The liquid has no adhesion to the soil. The dropbodies are held in equilibrium by the forces acting in the body (surface stresses and gravity), which give a mathematically fixed vertical section (fig. 3). By a distinct horizontal section belongs one distinct height.

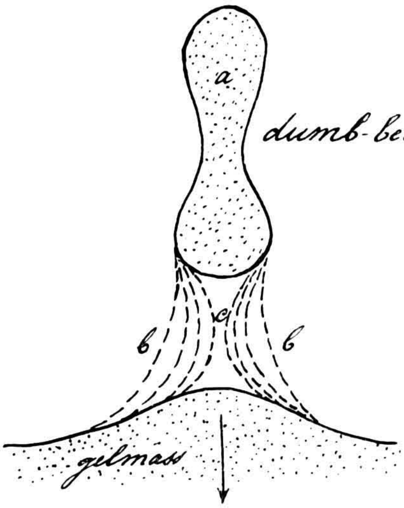

Fig. 2.

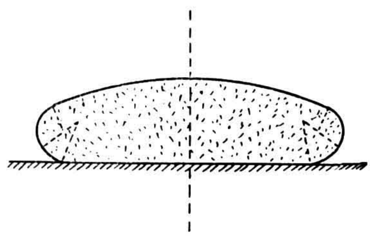

Fig. 3.

We consider now a drop of circular shape, whose top has the design of the original gelmass. The part with the smallest radius of curvature will dry the soonest, the quantity of liquid being there the smallest and the supply of heat the biggest on account of the radiation of the soil. The bottom of the drop will be covered also by a film. The whole body of the drop is then enclosed by a film. Through the desiccation the film will be subjected to contraction. The liquid mass inside the drop will get a pressure, which will be increased by the development of gas- and dampbubbles. This pressure will give the fluid body a globulous shape as far as its original shape and the gravitation will allow. The original bottom of the drop will normally be smaller than the upperpart of the body. The limit between the upper and lower part is formed by the brim, which will be later the keel. How the brim will demonstrate itself, depends from the grade of desiccation at the moment the drop gets its globulous shape. When the film of the swollen drop cracks, a part of the gas will escape and the pressure will lessen. The body will partly sink. Part of the bottom will show a flat surface, and whereas the bottom was globular and the situation of the object labil, the flattened part can be excentric.

The sculpture will depend from the speed of the desiccation. When it is going slowly by diffusion, the water and gas will escape with a small development of gasbubbles, whose impressions join the design, which the drop has got from the original gelmass. In case the film was already too strong the original design will be for the greatest part the final one and the moisture escapes by diffusion. Whereas the gasbubbles, formed inside, rise, the topside of the objects will show a stronger sculpture than the bottomside. The bottomside is getting also a supply of heat; gasbubbles will be formed too, which will stick to the film. The bubbles, which leave the film, will rise to the top and will leave their traces behind in the viscous mass or will stop somewhere in the mass. The bubbles on the top will partly flow together or can form rows, rosettes etc. Radial arrangements with the top of the object as a center can occur. When the mass is hardened we find the prints of these gasbubbles back as fine and coarse pits, gutters, grooves etc. The thin film, which covered these cavities will become after desiccation too subtile to resist later the pressure of the covering beds.

It will not be rare, that the envelopping film bursts over a row of gasbubbles in consequence of the contraction by the desiccation. Is this crack situated on the topsurface, the edges of the crack will open. The thick fluid will stick to these edges and will stay concave. The surface of the crevasse behaves itself as the original surface. Small gasbubbles can make new prints on them. When the bursts or cracks are on the sides of the object, it is possible to get sharp cuts with rounded ends. The thick liquid will stay more or less vertical between the upper and bottom surface. By many Billitonites the edges are so thin that they become transparent (fig. 4).

Fig. 4.

Sometimes Billitonites have deep aequatorial cuts. The upper and lower surfaces shrink. We get surface tensions with radial directions to the centres of their surfaces with the consequence that the skin can split at the aequator. While in the interior of the tectite the material is still viscous, these cracks will stop somewhere.

When a rather big gasbubble is lying under the film and the upper-part of the liquid is already hardened, the underpart of the gas-bubble will stay in the liquid mass. By the shrinkage of the kernel the lower part of the gasbubble must be pulled to the inside of the kernel and the funnel is born. It is obvious, that funnels will never intersect one another.

When several big gasbubbles settle below the film in the form of a rosette and the bubbles are pressed against one another, the upper and lower part of the bubbles are rounded. The central space between the bubbles is filled with the fluid mass with sharp edges, where two gasbubbles meet (fig. 5 and 6). When this mass hardens the problem of the mysterious tables is

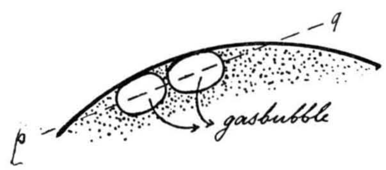

Fig. 5.

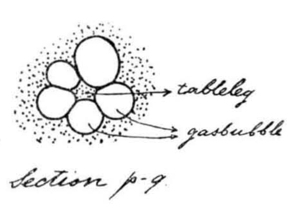

Fig. 6.

solved. When a tableleg is hardened, this will not be the case with the kernel. This kernel will shrink by loss of moisture. The leg is fixed to the shell and will not follow the shrinkage of the kernel. Round the lower end of the leg a deepened gutter will arise.

In the case several tables are present it is clear, that the tops of the tables are lying in one bend surface, the original surface of the drop. The table tops have principally the sculpture of the original film. The Billitonites have often the tables at the keel and by elongated objects at the ends. The tablelegs, which are vertical or nearly vertical will flow in the liquid state quicklier than the inclined ones and the horizontal ones will not flow at all. The more the tableleg deviates from the vertical, the chance to harden is bigger!

In case a table leg in the fluid state cuts off and the fluid is not as liquid as to disappear totally in the kernel you get a navel.

Not only the top surface of the tectite can have many gasbubbles, also the bottomside can be occupied by them. The kernel will be connected to the shell on many or on few places. An example is given in fig. 7. This shell will be separated from the kernel by the rude treatment, to which nature self exposes the objects lateron. The kernel is found later as a tectite. The surface, which is shows, is that of the dryed kernel and may not be confounded with the original surface of the dropbody. We have Billitonites with their original surface and specimens with a surface of the dryed kernel. The separated shell is found too in the form of sherds. A. LACROIX (Comptes Rendus N⁰. 26 of 1931 pg. 1688) has got from Indo China shells sometimes as parts of a sphere and sometimes as parts of an ellipsoide.

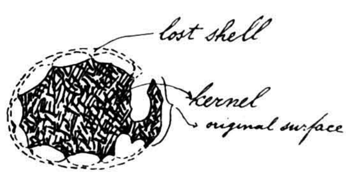

Fig. 7.

When the content of gas in the gelmaterial is high and when the shell has become too quick too tough as to allow the bubbles to pass, they can be collected to a big gasbubble inside the body of the tectite. The pressure of this gasbubble can have a great influence on the external shape of the tectite when the shell is still elastic. The greater the pressure the more the shape will be that of a sphere. I refer to the specimen of A. LACROIX (Comptes Rendus 1929 p. 285). The pressure inside was so big and perhaps also the stresses in the skin, that in the start of the attempt to cut the tectice in two pieces, the upper part was flung away.

The given genesis of the tectites makes foreign inclusions not probable.

To explain all the details of the form and sculpture of the Billitonites it was not necessary to have recourse to other forces of nature, as the action of acids.

In consequence of this desiccation hypothesis the Billitonites are formed on the spot or nearby, where they are found. They are formed in the lower parts of the country and are laying in the course of the future brooks. The objects could be transported only through the depression in which they are laying. Transport from the surrounding hills could not take place, because they could not be formed there. In Billiton people have never found a

Billitonite in the eluvial tindeposits. These eluvial exploitations are also numerous in number.

By transportation from a higher point in the valley downstream a Billitonite can be deposed on an already settled bed of sand or clay. It is not necessary to find them only on the bedrock.

The Australites. We have here to do with tectites with innate shapes. For the Australites the gelmass has to be split in drops with spheroïdal shapes in the time the adhesion with the soil existed, just the same that happens, when a solution is evaporated in a dish with a horizontal bottom too large for the small quantity of liquid. But this fact will have the greatest influence on the shape of the endproducts. In the case of the Billitonites the separated drops have a height corresponding with the horizontal diameter, in the case of the Australites the height of the drops can vary between a minimum till a maximum. The big difference between these two kinds of tectites is, that a Billitonite-drop can have only one distinct height belonging to its size of diameter, while an Australite-drop can have any amount of heights between a minimum to a distinct maximum height.

The separated geldrops will dry and also the bottom will get gradually free from the soil. But we will now consider a thick drop (fig. 8). The rim of the drop is thin and will be desiccated long before the other part of the drop and will get another appearance. It may happen also that parts of

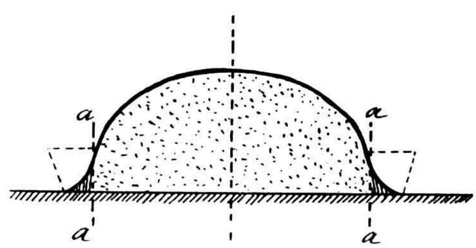

Fig. 8.

this rim and perhaps the whole rim is contracted in the body of the drop. When the thin rim breaks off later, the edges with the bottomline will be sharp. When the thin rim is not formed we will get at the ends of the bottomline curves with a small radius of curvature, which will give also a sharp borderline. In every case the angle of the flanks of the drop with the bottomline is a sharp one and will form the sharp keel of the Australites, a peculiarity of these tectites. During the hardening process the bottom part will become rounded and by specimens with great height always is the smallest part of the surface.

Now we will consider a drop with a small height (fig. 9). The rim will behave itself as the rest of the drop, because the volumes of liquid are now more comparable. The rim will generally be contracted in the drop body (fig. 9*b*.) and will form a ringshaped body. The bending action is a stronger one for thin drops than for thick ones. It is clear, that this action will occur in successive order and is the origin of the low curved ridges on the bottom side. The toppart will be pressed together and will form concentric folds. Depending from the thickness of the drop, the grade of

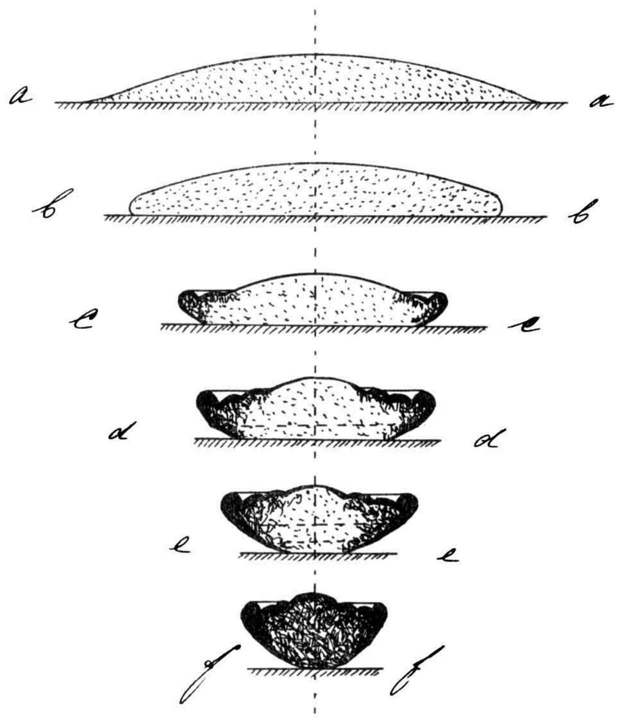

Fig. 9.

fluidity of the gelmass in the drop and the grade of convexity of the bottom, the gelmass will flow from the periphery to the center. A weakened area between the ring and the core of the tectite can arise. After desiccation this connection will be a weak one and a separation of the ring can take place. These separated rings are really found (E. J. DUNN "Pebbles" plate 58 fig. 1). Fig. 9 *a* to *f* gives the development from a drop to a buttonshaped Australite. The bottomside in this case forms the greatest part of the surface. Very often these Australites have near the top a depression, originating in the endstate of desiccation.

We can get also in the center of the core a gasbubble of big size. The higher the gaspressure inside, the more the Australite will get the form of a sphere with a keel, as the splendid Australite from Kangoro Island exhibits.

With the aid of this theory the rare specimens of Australites like a watchglass and the one DARWIN mentions can be explained without difficulty. When we have a big circular drop with a very small height, the shape of a watchglass arises by the shrinking of the top surface and the bending of the bottom surface. When the gelmaterial inside can flow to the center, we get the Australite of DARWIN. The concentric ridges at the outside of the surface of this specimen are already explained above.

The sculpture of the Australite is very simple. Whereas they originate from drops separated in a state of high fluidity, they cannot have the original design of the gelmass in contradistinction with the Billitonites. Fluidal structure on the surface is impossible. Inside of the tectite we will have fluidal structure caused by the bending up of the bottom.

The Moldavites. The Moldavites can be divided in two groups. The biggest group is formed by the sherds. The other group, mostly originating from Mähren, have their innate shape, with other words a spheroïdal shape.

As we have seen several factors have to be taken in account for the genesis of the tectites. The gelmass can have by an advanced state of desiccation a vertical height too big to be split in small parts. The drying process takes place over the whole top surface of the gelmass. The influence of the surface stresses will disappear proportionately with the hardening of the surface. Separation of dropbodies will not easily happen but can happen. Where the mass has the smallest height, it will get till the bottom sooner a higher degree of viscosity than there, where the mass has a greater height. When the deeper parts will dry, the original horizontal top surface of the gelmass will get inclinations, dipping in the direction of the deeper parts. A gentle flow of the viscous material will take place in these directions. The surface of the gelmass was also crowded with bubbles and bubble-prints, which will be stretched by the flow in parallel grooves of different sizes. The fluidal structure is now evident. The upper surface will have a stronger sculpture than the bottom one. When the hardening process is achieved the mass will be broken to pieces through contraction, differences of temperatures a.s.o. and the places, where these fractures will occur will be the weak spots. With this sort of tectites we only have one kind of sculpture, the altered sculpture of the primitiv gelmass in contradistinction with the objects with innate spheroïdal shape. Now it is also evident, that the very fine feathershaped structure on the surface, which evokes the idea by W. HAIDINGER as to be "gleich einer abgeblasenen Milchhaut", is often met with the Moldavites and occasionly with the Australites, because they have the undisturbed original surface of the gelmass of great fluidity. That these very fine designs are preserved is a proof, that the material of the tectites is not easily attacked by the weathering agencies and that the forming of the sculpture by weathering is not probable.

As a consequence of this theory the Moldavites in sherdshape originate from larger gelpools. A great quantity is formed on one spot. It is then no wonder when they are later found abundantly on some localities as is really the case in Bohemia.

The Tectites from other localities. The tectites of most of the other localities have an innate spheroïdal shape with a sculpture comparable with the Billitonites but never as strong and varied.

The Queenstownites must be treated separately, because their shape and the localities, where they are found, differ from the other described tectites. They are found on the slopes of hills. The figures given by FR. E. SUESS ("Mitteilungen der Geologischen Gesellschaft in Wien", part VII, 1914) and his description give me the suspicion, that the Queentownites are the soldified rests of a stiffy material flowing gently downward. I suppose, that this gelmass trickled out of fissures in the rocks of the mountain and is formed in these acid rocks. While the origin of the gel is another one, the chemical composition will differ from the gelmasses from which the other kinds of tectites originate. This is indeed the case. I refer to the just mentioned paper of FR. E. SUESS. On page 110 he comes to the consequence, that the Queenstownites are an other kind of tectites.

In the course of the geological ages it will not be a rarity, that a gelmass would dry. The origin of the tectites is attributed to such a gelmass, but is it necessary, that tectites always will be born by such a desiccation? The answer of this question will be treated in the next section.

A more general application of the desiccation theory. The occurrence of tectites was formerly only known in Bohemia, Billiton and Australia. In the course of the years many other localities are discovered. And this is comprehensible, when the tectites are born out off a gelmass, originating from the weathering down of rocks. The conditions, to which a gelmass has to obey, to generate tectites, have to be still unknown but probable distinct ones. But when these conditions do not prevail, what will be the endproducts of the desiccation? These endproducts must then be found abundantly and till now not be recognised to be the desiccation product of a gelmass. As main product I keep the pebbles between the gravel in the rivers, as found in our Dutch rivers, with a spheroïdal shape and inside consisting of silicious material very oft with LIESEGANG's rhythmical precipitation running parallel with the surface. My suggestion is, that they are products of desiccation of a gelmass. The rhythmical precipitation took place when the separated dropbodies with a film came in contact with water including weatherings products. As they are formed in the lower parts of the country, they will be collected by the rivers lateron and mixed with the gravel formed in other ways. In the same way the quartz nodules with water inside, the chalcedony and agate amygdales (Uruguay) with a weak salt solution inside (synäresis?) may have been formed.

Against the developped desiccation theory some objections can be made. The first one will be, that in the geological knowledge the existence of gelpools is unknown. Silicification of rocks is a common feature caused by solutions. In case these solutions could not more penetrate into the rocks, they can form pools and be subjected to desiccation. The geological, geographical and climatological conditions have to cooperate.

The chemical question of the tectites is still a puzzle. The general opinion is that we have to do with a glass, but is everything a glass that has the properties of a glass? Glass is a molten mixture, the proof has to been given, that the material of the tectites is a molten product and nothing else.

With this desiccation hypothesis I hope to have brought the problem of the tectites a step nearer to its solution.

Medicine. — *On the occurrence of heterophyl antigene and its importance for a specific cancer diagnosis for human beings.* By L. DE KROMME and J. R. DE BRUÏNE GROENEVELDT (from the "BRUÏNE GROENEVELDT" laboratory, Cancer Research department of the Instituut Voor Preventieve Geneeskunde, at Leiden). (Communicated by Prof. J. VAN DER HOEVE.)

(Communicated at the meeting of April 29, 1933).

In the course of the researches carried out by WATERMAN and DE KROMME in regard to the serumreaction of FREUND and KAMINER and the preparation, from the reticulo-endothelial system, of a substance capable of dissolving cancer-cells (Report Kon. Akademie van Wetenschappen, te Amsterdam, dept. Natuurk. Vol XXXVI N⁰. 3 and Biochem. Zeitschr. 205 Bd. 1—3 Heft) a new phenomenon was discovered, viz. that of the agglutination of cancer-cells.

On a drop of a cancercell-suspension, 1^{cc} being added to normal serum and being allowed to stand for some hours at 37°, it was found, that a part of these cells had been dissolved. Carcinomatous serum does not contain the substance responsible for this carcinolysis, whilst in its place a cancer cell-protecting-substance occurs, which protects the cells against the dissolving property of normal serum.

It has now been found that diluted serum can produce a very strong agglutination of the cancer cells. This phenomenon could be systematically and regularly produced and made accessible for accurate analysis.

The technical side of this question was fully dealt with in the "Zeitschr. für Krebsforschung" (29 Bd. 4 Heft). Briefly stated the following description can be given: to 1 c.c. of the serum-dilution (diluted with isotonic phosphatebuffer-solution after Sörensen; p_H 7.7), a drop of a freshly prepared cancercell-suspension (washed in FREUND solution; p_H 5.4) is added. After shaking, the testtube is allowed to stand for some time (8—24 hours) at 37°. The agglutination manifests itself by a strong irreversible clotting together of the cancer-cells, giving a marcroscopic and clearly perceptible binding and adsorption of the serum colloids.