Es dürfte also aus dieser Darstellung wohl mit genügender Klarheit hervorgehen, daß in diesen vier Stufen eine Organisationsreihe vorliegt, die einen Weg zum Verständnis des biologischen Ganzheitsproblems weist. Ich habe schon 1938[1] darauf hingewiesen, daß sich aus der Vorstellung einer artspezifischen Proteinmatrize bis zu einem gewissen Grade die Entwicklungspotenzen eines lebenden Systems zumindest theoretisch aus der molekularen Struktur des Keimplasmas ableiten lassen. Die in der Lebensphase zweifellos herrschende Entelechie muß ja in irgendeiner Weise stofflich fundiert sein. Auch vom streng naturwissenschaftlichen Standpunkt aus ist daher die Annahme einer solchen Entelechie als regulatives Prinzip gestattet, solange dieses nicht konstitutiv gebraucht wird (KANT).

Die im ersten Teil schon hervorgehobene Eigentümlichkeit des Chemismus der Lebensphase, daß aus den zusammenbrechenden Ungleichgewichten sich immer die ursprünglichen Gleichgewichte durch endergonische Vorgänge wiederherstellen können, birgt eigentlich schon den Begriff der Selbstregeneration in sich, auf welchen am Eingang dieser Betrachtungen hingewiesen wurde. Es wird dadurch der Forschung ein Weg gewiesen, indem sie den Begriff des biochemischen Aktionsfeldes mit dieser Vorstellung vereinigen muß.

Die Analyse der elementarsten Phänomene des Lebens wird daher bei einer Betrachtung des molekularen Geschehens in der Lebensphase beginnen. Durch dieses Verfahren wird die Forschung allmählich eine hierarchische Ordnung von immer höher organisierten Wirkungseinheiten aufstellen können, die zu einem allmählichen, teilweisen Verständnis desjenigen Bereiches der Lebensvorgänge führen wird, der naturwissenschaftlich überhaupt erkennbar ist.

[1] Protein-Synthese und Gen-Struktur: Schweiz. med. Wschr. *68*, 959 (1938).

Summary

It is demonstrated that in a number of metabolic reactions intermediary reactions are coupled both as regards material and energy with the main metabolic process. In many cases energetic coupling of partial reactions is not at all clear. Our investigations on the *d*-amino-acid-oxydase demonstrated that the so-called true enzyme can, with amino-acids and proteins, yield numerous "complex-enzymes" each having a different action. These investigations have been extended to other enzyme-systems, and the conclusion was reached that simple protein-enzymes are transformed into complex-enzymes in the living-matter. It is assumed that the formation of these complex-enzymes is in principle a regulatory metabolic action. The assumption of chronological action of enzymatic processes is not satisfactory if judged from a biological point of view. It is therefore assumed that in many cases all enzymes act on the substrate simultaneously and that consequently an "enzymatic field of action" (enzymatisches Aktionsfeld) is created. If a molecule of substrate gets into such a field it is probably degraded in a direct way and not chronologically. In many cases partial enzymes and intermediary products exist only potentially and not actually.

If such a "field of action" is disturbed by experimental influences it is possible to isolate intermediary products, which under normal conditions would never be formed owing to the fact that their existence is only potential. In living matter a hierarchic order is therefore assumed. Protein-enzymes, symplex-enzymes and the "field of action" form a higher level of organization and the hypothesis of DRIESCH, which governs every living system, may gradually be recognized.

On some Problems of Alpine Tectonics

By J. CADISCH, Berne[1]

1. *The arc structure of the Mountain-Range*

Each student of a geological map of the Alps is likely to be struck at a first glance by the subdivision of the structure into the two impressive arcs of the Western and Eastern Alps respectively. These members of the alpine structure may be considered as flow structures of the first order in the exterior crust of the Earth. Much has already been written on the possible origin of this peculiar feature. Two opinions are in diametrical opposition to each other: While the one supposes these arcs to be as such of primary origin, the other presumes that they are produced by strong deflection processes to which the originally straight zones had subsequently been subjected. A point in opposition to this view is the hardly disturbed continuation of the tectonic members from the Western into the Eastern Alps. Had the arcs been produced by strong deflections a pronounced compression would have resulted on the concave side while intense tension would have acted on the convex side. But no such features of either type can be detected excepting perhaps the rather well marked transverse folding in the area of the Alps of Ticino (South of the St. Gothard pass). Consequently, it would appear most plausible to assume an original arc-shaped structure from which the present-day features have gradually developped.

We now know, owing to the geophysical researches made by G. CASSINIS, M. DE PISA, E. A. VENING MEINESZ and H. P. COSTER[2] that the alpine structural

[1] Institute of Geology, University of Berne.

[2] H. P. COSTER, The Gravity Field of the Western and Central Mediterranean (Groningen 1945).

arcs are not uninterruptedly connected throughout. Thus e. g. the alpine branch extending from the Betic Cordillera to the Balearic Islands breaks off to the South and East of Sardinia and finds its continuation only again in the Western Apennine. On the other hand, crossfolding (linkage) of the structural elements can be established in the boundary region between the Western and Eastern Alps, a factor which compells us to suppose that the movements took place alternatively in both arcs. Similar conditions exist in the boundary area between the Southern Alps and the Dinarides. On the one hand, the Southern Alps are thrust southwards over the Dinarides, and on the other hand, they are folded with them in a SE-NW trend. Thus, the result in the boundary zones between the arcs of mountain systems is a crossfolding which is also accompanied by a complicated lay-out of the valleys.

Scheme of the succession of nappes in the region between the Western and Eastern Alps

Western Swiss Alps	*Eastern Swiss Alps*			
	Oetztal-Nappe predominantly gneisses Silvretta-Nappe predominantly gneisses	Inntal-Nappe Lechtal-Nappe Allgäu-Nappe predominantly sediments		upper Eastalpine Nappes
	Scarl-Nappe (Dolomites of the Lower Engadine)			
	Umbrail-Nappe Ortler-Nappe Languard-Nappe	predominantly Campo-Nappe sediments predominantly gneisses		middle Eastalpine Nappes
Dent Blanche-Nappe s. l.	Bernina-Nappe Err-Nappe	Engadine		lower Eastalpine Nappes
	Sella-Nappe Margna-Nappe	Nappes	upper	Pennine Nappes
Monte Rosa–Bernhard-Nappe or Mischabel-Nappe	Suretta-Nappe Tambo-Nappe		middle	
Simplon-Nappes { Monte Leone-Nappe Lebendun-Nappe Antigorio-Nappe	Adula-Nappe Soja-Nappe Simano-Nappe Lucomagno-Nappe Leventina-Nappe		lower	
	Helvetic Nappes Autochthonous massifs and sediments			

2. *The internal structure of the arcs*

Nowadays, alpine geologists generally agree in considering the Alps to be overthrust mountains, i.e. rock complexes partly folded (recumbent folds with great amplitude) and partly unfolded ("Deckplatten") which having been transported over wide distances participate in the building up of the mountain range. If any elements of them may still be referred to as autochthonous this may at the best apply to the Central Masses of the Helvetic marginal zone (Aar Massif, Gothard Massif and others) and to their sedimentary cover; the roots of the nappes and certain portions of the adjacent Southern Alps are autochthonous.

In the preceding table we merely give the succession of the tectonic units as established for the boundary area between the Western and Eastern Alps.

The correlation drawn with units of the Valesian Alps should be taken as approximate. However, the geologist was naturally forced to trace and correlate the tectonic units throughout the entire Alps. The lengthy discussions on the correlation of nappes caused those people not directly interested in the subject to consider the discussions as "geofancies," thereby often discrediting alpine investigations. To-day we do no longer attach such great importance to these matters since we have recognized how much the nature of the nappes depends upon the material, the extent of their development and especially upon their overburden. R. HELBLING[1] has shown that the existence of several plastic horizons may give rise to a large number of nappes and slices originating from one and the same Helvetic series of strata (Verrucano-Nappe—Permian Nappe, Liassic Nappe, Malm Nappe, Cretaceous Nappe, etc.).

3. *The age of the Orogenesis (mountain-building)*

Alpine folding set in during the Mesozoic (Liassic) and was especially accentuated during cretaceous and tertiary times. The mountainous ranges produced thereby involve large complexes of the substratum of old rocks which we have to consider as parts of earlier orogenies. Folded metamorphic beds which are older than the non-metamorphic Palaeozoic of the Eastern Alps (zone of Grauwacke), such as e.g. the thick floating masses of gneissic rocks to the West and East of the inlier (window) of the Hohe Tauern (Silvretta, Alps of Oetztal, Alps of Mur, etc.) can be considered as of possible pre-Cambrian (archaic) age. These masses are to be considered as the overthrust continuation of the Hungarian Betwixt Mountains. Also in the Aar and Gothard Massifs a very old orogenesis, probably archaic, has to be assumed.

The Caledonian (i.e. early palaeozoic) folding period could not be traced in the Alps unless the transgression of the upper Devonian (Clymenia limestone) ascertained in the Eastern Alps may be interpreted as its "echo."

On the other hand, the *Hercynian folding* period (Variscan orogenesis of the German geologists) is ascertainable throughout, two phases of it having been found in the Swiss Alps, viz. one dated as pre-Upper Carboniferous, and a Permian one which is shown by the unconformable overlap of upper Permian and Triassic.

The "alpine" folding period is above all characterized by upper cretaceous and tertiary main foldings (orogenic paroxysms). In the Eastern Alps (Hallstatt—Ischgl) Upper Cretaceous (Gosau beds) overlaps nappes which probably date from middle cretaceous time. Later on, the mountains were thrust over their own tertiary erosional products.

In the Jura Mountains older displacements, viz. Eocene and Oligocene, are to be connected with those of the Rhine Valley Graben. However, the main folding in the Jura Mountains is Pliocene.

4. *Mountain-building and formation of igneous rocks*

In contrast to the ideas advanced in the early time of geological research in the Alps (L. v. BUCH, B. STUDER), the opinion prevailed at the end of the last and the beginning of this century that the alpine orogenesis had practically nothing whatever to do with magmatic processes; to-day still other views are held.

First of all, the eruption of basic magma (ophiolites) occurs in the early stage of the orogenesis (embrionic phases, from Lias to Malm) and in the Upper Cretaceous paroxysm. Serpentine, Gabbro and Diabases intruded into the fold-structure. The "Diabases" correspond as regards their composition with the Spilites of anglosaxon nomenclature, their albites are, however, of primary origin and could, according to H. GRUNAU, be termed albite-basalts.

Secondary albitization plays an important part in the metamorphic series of the Pennine Nappes (Valais, Grisons). P. BEARTH and W. NABHOLZ assume that this albitization took place simultaneously with the ophiolithization. The strong albitization in the Tauern (Eastern Alps), where original calcareous slates consist of up to 80 and 90% of albite, appears, according to H. P. CORNELIUS[1], to have taken place only during a later phase of mountain-building.

In contrast to the basic rocks (ophiolites) the thick masses of granite and tonalite intruded the alpine structure only during the final stage of its upheaval, or even afterwards. The more important occurrences are: Biella and Traversella (Piedmont), Bergell = Valle Bregaglia (Switzerland—Lombardia), Adamello (Lombardia—Alto Adige), Kreuzberg = Monte Croce and Iffinger = Monte Ivigna near Meran, Massif of Brixen = Bressanone (Alto Adige), Riesenferner South of the inlier (window) of the Hohe Tauern, Eisenkappel in Carnia. These masses of granite and tonalite lie on the one hand in the region of the roots of the nappes or in their vicinity, and on the other hand in a zone which stretches right across the Alps from the Colli Euganei near Padova to the extinct Kaiserstuhl volcano in the Rhine Valley Graben.

Various authors considered the rising of granitic magmas at a later stage of alpine folding as a process of granitization; they spoke of the forming of migmatites supposed to be in connection with the metamorphosis (injection) of those portions of the nappes near their root. To some degree this view was confirmed by the discovery by L. KÖLBL[2] who in 1932 found that the frame of the window of the Hohe Tauern in the Valley of Habach (Salzburg province) shows signs of melting by the "Central gneis" of the Hochvenediger group. H. P. CORNELIUS held similar views with regard to the granite of Monte Rosa. P. BEARTH[3] recently found out that the granite of Monte Rosa (East of Zermatt) had pierced through gneisses which previously, during the folding up of the Alps, had been

[1] R. HELBLING, Zur Tektonik des St. Galler Oberlandes und der Glarner Alpen, Beitr. Geol. Karte d. Schweiz, NF *76* (1938).

[1] H. P. CORNELIUS und E. CLAR, Geologie des Großglocknergebietes, I. Teil, Abh. Zweigstelle f. Bodenforschung, *25*, 1 (Wien 1939).

[2] L. KÖLBL, Sitzungsber. Akad. d. Wiss., Wien, Math.-nat. Kl. I, 141, (1932).

[3] P. BEARTH, Über spätalpine granitische Intrusionen in der Monte-Rosa-Decke, Schweiz. min.-petrogr. Mitt. 25 (Zürich 1945).

metamorphosed, crevassed and foliated (cleaved). The question now arises whether further masses of granite formerly designated as of Palaeozoic age have now to be considered as migmatites. Since mesozoic sediments are only pierced by granites of the root zone, but not by the central granite bodies, evidence for their younger age could only be supplied by means of detailed tectonical analyses.

Various authors recently tried to consider the orogenesis in its relation to and dependance on processes at greater depths. In 1942, S. v. BUBNOFF[1] wrote on the relation between orogenesis and magmatic activities, and on the transportation of displaced masses and magmatic currents. According to him, alpine structures would comprise several layers. Below the unaltered arch of the nappes there would be a layer

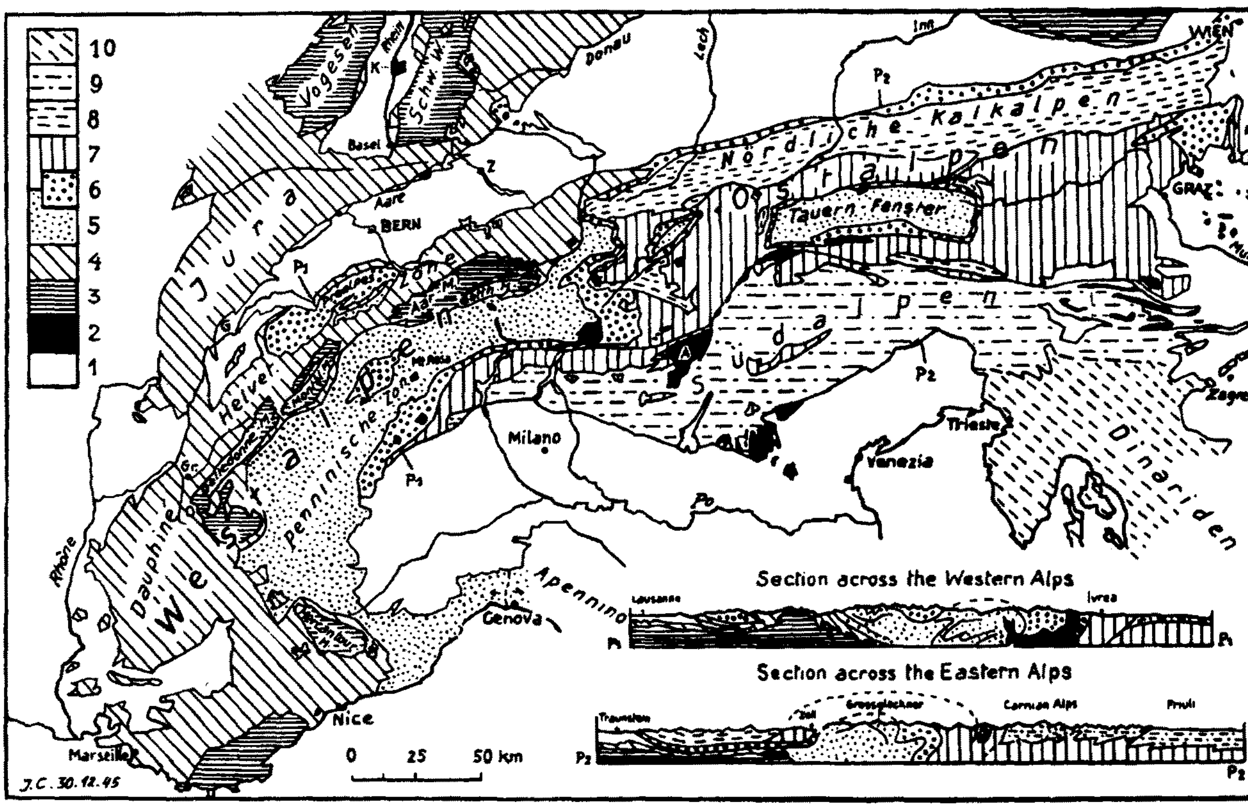

Fig. 1. *Tectonic sketch map of the Alps.* 1. Tertiary and quaternary formations of Forelands and Basins. 2. Tertiary and quaternary igneous rocks. 3. Autochthonous Massifs and Horsts. 4. Sediments of the Basins, of the Jura Mountains and of the Helvetic zone, predominantly mesozoic. 5. Pennine Nappes. 6. Upper Pennine and infra-Eastalpine Nappes. 7. Crystalline base and early palaeozoic rocks of the Eastern and Southern Alps. 8. East-alpine sediments. 9. Southalpine sediments. 10. Dinaric sediments.

5. *On some newer hypotheses of mountain-building*

Two types of hypotheses will hereafter be briefly discussed: firstly those concerning the structure of the Earth's crust in general and as such applying also to mountain formation, and secondly those proposed by alpine geologists as based upon field observations. The latter views will interest us more closely.

W. J. BUCHER[1] supports the theory that periods of mountain formation coincide with periods of general regressions of the oceans, periods of orogenetic inactivity being also periods of transgression. According to this author, deep sea troughs with their linear arrangement i.e. the large geosynclines, originate during anorogenic phases, while the folding up of the mountain ranges takes place during orogenic phases of a diastrophic cycle.

[1] W. H. BUCHER, The Mountain-Building Cycle, Transactions of 1940 of the American Geophysical Union.

affected by metamorphism and granitization, and at still greater depth a zone of pronounced flow movements. Deep down material is flowing off, and in the roof of the "swallowing zone," rocks are accumulated.

A. RITTMANN[2] supporting A. HOLMES to some degree, tried to explain mountain building as resulting from thermal convection. A strongly marked horizontal fall in temperature is thought to prevail from oceanic regions towards the continents thereby producing a flowing movement in the direction of and extending underneath the continent. In the marginal areas of the continent this flowing movement becomes so strong that as a result of tension a geosyncline will originate. The continuous tension creates fissures through which

[1] S. v. BUBNOFF, Schollentransport und magmatische Strömung, Abh. preuß. Ak. d. Wiss., Math.-naturw. Kl. 18 (Berlin 1942).

[2] A. RITTMANN, Zur Thermodynamik der Orogenese, Geol. Rundschau 33 (1942).

magma reaches the surface. Simultaneously, the Sima substratum cools down and consequently sinks deeper. Masses of Sial dragged down with it are now subject to pronounced heat; they become specifically lighter. Thence an ascending movement sets in finally resulting in lifting up the geosynclinal masses to form the mountain-ranges.

With this hypothesis A. RITTMANN to some degree shares the views held by O. AMPFERER[1, 2] who, on the basis of field observations extending over many years, expressed his theory for the first time in 1906. According to this author's theory of understreaming ("Unterströmungs-Theorie"), formerly known as the theory of swallowing ("Verschluckungs-Theorie"), wrapped in. Therefore any description of large scale sliding processes is merely a matter of conjecture.

AMPFERER also strongly emphasized the fact that the alpine nappes were moved over an erosional landscape (relief-overthrust), an observation made earlier by ARN. HEIM. According to AMPFERER, also subsequent overthrusting from East to West, i.e. at right angles to the normal alpine direction of movement, had ensued as relief-overthrust (Rätikon Mountains, Keschgroup).

AMPFERERS ideas did not meet with approval amongst Swiss geologists. Admittedly H. SCHARDT (1893) and M. LUGEON (1896) had originally ascribed a great part to sliding by gravity. While H. SCHARDT (as reported by his assistant Dr. H. SUTER) maintained his opinion,

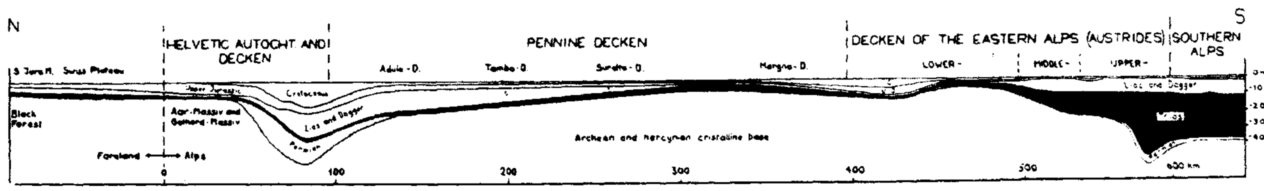

Fig. 2. *Section across the original alpine sedimentary region*, constructed by means of unrolling the nappes and restoring the original sequence.

folding of a relatively wide zone of the Earth's crust is only possible if simultaneously its substratum is sinking and flowing off. The sinking masses are partly replaced by ascending liquid magma.

In his cross section through the Swiss Alps, AMPFERER groups the single structural elements as follows: 1. The Northern marginal zone of the Helvetic Massifs and Sediments (autochthonous) form, together with the Helvetic Nappes, a slab acting as an isolator against the depth. 2. The "Klippen" nappes (Klippe = nappe-outlier) of the Prealps (Western Alps) and the nappes of the Northern calcareous Alps are described as pushed out excess building material. 3. The Pennine Nappes with their gneiss cores build up the central depression zone. 4. The Southern marginal zone with the granitic intrusive masses is termed as young melting zone. Zones 3 and 4 are "open to the influence from the depth."

From the beginning, O. AMPFERER has considered the sliding of superficial groups of strata as a phenomenon associated with the sinking processes. The large Glarus-Nappe (ref. 6, p. 237) was regarded as a sliding nappe (nappe de glissement) and the frontal folds of the Helvetian Nappes of Eastern Switzerland termed as frontal involutions (Einrollungen).

A check on these hypotheses shows that it is a very difficult task to provide any proof of the existence of such pronounced slide-tectonics. Exclusive gravity effects do not come into consideration where the nappes met with resistance and were steeply tilted up or

M. LUGEON together with E. ARGAND pleaded for decades for the existence of pure and simple thrust tectonics in the sense of E. DE BEAUMONT.

In 1940 M. LUGEON[1] returned to his earlier interpretation. He described the displacement of the "klippen" nappes as sliding by gravity just as E. GAGNEBIN[2], A. LOMBARD and D. SCHNEEGANS had done. The primary cause of this process was sought in the continental drift, i.e. the slide-tectonics were subordinated to the same mechanism which E. ARGAND had applied in his vice-theory (Schraubstock-Theorie).

In contrast to the hypothesis of sliding which is difficult to control, AMPFERER'S theory of swallowing may to a certain degree be checked and, as we believe, accepted. We had tried to check this theory in 1934[3] when we undertook to unroll the alpine nappes, and attempted to reconstruct their position in the original sedimentary basin. In carefully measuring out with the curve meter all the nappes in the boundary area between the Western and Eastern Alps, we arrive at an original width of about 630 km for the strip of the Earth's crust that had developed into the orogeny. The present-day width of the mountains is 150 km. Thus a compression has taken place from 100% to 24%. Now, since on the one hand in the Northern marginal zone (Aar Massif) the palaeozoic, mesozoic and tertiary sediments are in direct connection with the me-

[1] O. AMPFERER, Grundlagen und Aussagen der geologischen Unterströmungslehre, "Natur und Volk", 69 (Frankfurt a. M. 1939).

[2] O. AMPFERER, Über die Bedeutung von Gleitvorgängen für den Bau der Alpen. Sitzungsber. Ak. d. Wiss., Wien, Abt. I, 151 (1942).

[1] M. LUGEON et E. GAGNEBIN, Observations et vues nouvelles sur la géologie des Préalpes romandes, Bull. Lab. Géol. etc., Université Lausanne, No 72 (1941).

[2] E. GAGNEBIN, Quelques problèmes de la tectonique d'écoulement en Suisse orientale, Bull. Lab. Géol. etc. Université Lausanne, No 80 (1945).

[3] J. CADISCH, Geologie der Schweizer Alpen (Zürich 1934).

tamorphic substratum of old rocks (gneiss, granite and others), and on the other hand the same connection exists in the region South of the Alps (Lugano–Bergamasca), it has to be assumed that the basement rock must have suffered the same compression. This, however, is only possible by its *sinking* to the depth. This conception of mountain formation coincides to a wide extent with the hypotheses of A. C. LAWSON (1927) and W. BUCHER[1] (p. 211/12).

The difficulties in the interpretation increase if we visualize the Jura Mountains exclusively. A. BUXTORF by his investigations confirmed the views of ED. REYER who on the basis of purely theoretical considerations had presumed that the Jura sediments had been folded up above a basal sliding plane, and he recognized the triassic anhydrite group as the lubricant. According to this author, the folding in the Jura Mountains has been caused by a pushing action exerted by the Alps.

In 1934 and 1942 the writer[2,3] pointed out some difficulties with which he was faced on considering this interpretation. In the Central Jura the compression reduced the deposition areas to about 75%, in the Eastern Jura, due to overthrusting, the narrowing increased to 62%. The corresponding absolute measurements amount to 10·2 and 6·6 km respectively. If the hitherto prevailing conception is adhered to a hiatus of corresponding width should exist in the South side of the Jura arc, i.e. the tertiary formations of the Molasse should have overridden this hiatus. If this solution is not acceptable – it is not a probable solution – there remains only one possibility: the substratum of the Folded Jura, granites and gneisses, Permian and Buntsandstein has been reduced in tangential direction by approximately the same amount as were the younger sediments.

As in the Alps, sliding tectonics were recently thought to be also detectable in the Jura Mountains. Against this hypothesis there is the fact that a sliding plane sloping towards the Paris basin could not be observed anywhere. The surface of the basement dips towards the concave side of the Jura arc; moreover, as shown by recent borings (Salins, Baumes-les-Messieurs) the surface of the basement does not form a plain surface at all. M. LUGEON[4] therefore assumed that the Jura Mountains were folded by pressure action exerted by the alpine sliding nappes. Therefore, due to gravity effects a mass displacement would have taken place away from the Alps. This conception has recently been accepted by D. AUBERT[5] who examined the region of the Dent du Vaulion (Swiss Jura Mountains). Furthermore, he arrived at the conclusion that the anhydrite group had acted as lubricating horizon only between the superficial folding action and the underlying imbricated structure. Consequently, a similar layer-structure would be present here as had repeatedly been observed in the Alps. We wish only to refer to the corresponding part played by the plastic Raibler beds (Carnian, Trias) of the Swiss National Park separating an upper structure comprising limestone and Dolomitic material from a lower structure built up by triassic quartzite and -sandstone, Permian, and older gneisses. In contrast to conditions in the Jura Mountains, both layers are well exposed in the Alps due to deep reaching erosion.

The example of a case of sliding by gravity mentioned by D. AUBERT applies to a recumbent fold which slid down into the Vallorbe syncline without influencing in any way the obstacle of the Mont d'Orzeires. It is question here of a secondary tectonical phenomenon which is hardly observable in the section 1:100 000.

Summarizing, we consider that the building plan of the alpine mountains has to be brought into relation with the tectonics at depth of its substratum. The sinking of voluminous masses is an ascertainable process and the subsequence of the sinking is the flowing off of large tracts.

We know of no reliable evidence that would prove the forming of whole mountain-ranges or large portions thereof by means of sliding by gravity. Some importance may be ascribed to gravity in connection with the formation of mountains on the surface, but it is doubtlessly always associated with other influences. Among such influences one must consider cosmic effects (westward drifting, drifting away from the poles), thermal and radioactive processes, and magmatic differentiation. It will be the task of the geophysicists to evaluate the participation of the various causes; the geologist has, for the time being, to consider them in their total effect.

Zusammenfassung

Der vorliegende Aufsatz vermittelt zunächst einen Überblick über den alpinen Bauplan. Anschließend gelangen einige Probleme der Gebirgsbildung zur Besprechung. Die Beziehungen zwischen Plutonismus und Vulkanismus einerseits und Orogenese andererseits werden kurz gestreift. Der Autor versucht vermittels Abwicklung des alpinen Deckenbaues, das heißt Zurückversetzung der Schubmassen in die ursprünglichen Sedimentationsräume, nachzuweisen, daß während der Auffaltung des Kettengebirges eine weitgehende Versenkung von dessen Unterlage erfolgte. Wahrscheinliche Folge dieser «Verschluckung» (O. AMPFERER) ist die seitliche Verdrängung magmatischen Materials. Erfuhren diese primären Vorgänge bis dahin zu wenig Beachtung, so wurde den Schwergewichtsgleitungen von verschiedenen Autoren in letzter Zeit zu große Bedeutung beigemessen.

[1] W. H. BUCHER, The deformation of the earth's crust (Princeton Univ. Press 1933).

[2] J. CADISCH, Geologie der Schweizer Alpen (Zürich 1934).

[3] J. CADISCH, Die Entstehung der Alpen im Lichte der neuen Forschung, Verh. Naturf. Ges. Basel, 54 (1942).

[4] M. LUGEON, Une hypothèse sur l'origine du Jura, Bull. Lab. Géol. Université Lausanne, No 73 (1941).

[5] D. AUBERT, Le Jura et la tectonique d'écoulement, Bull. Lab. Géol. etc. Université Lausanne, No 83 (1945).