years. Approximately one half of this sum will be given by the General Education Board; the rest will be raised by the university. The zoological staff plans to use a portion of this fund for technical assistance and for fellowships.

AS reported in SCIENCE, a citizen has given to the University of Sydney, Australia, about $1,000,000. The *Journal* of the American Medical Association states that this gift is "for the specific purpose of establishing three chairs in the medical school and of equipping the necessary laboratories." According to the *Medical Journal of Australia*, the new professors of medicine, surgery and bacteriology will be required to devote their whole time to their tasks, which will include research. Heretofore the chairs of medicine and surgery have been filled by part-time professors. The salaries of the new professors of medicine and surgery are understood to be £3,000.

DR. PAUL S. MCKIBBEN, professor of anatomy at the University of Michigan, has been appointed to the chair of anatomy in the school of medicine of the University of Southern California, and Dr. Harry J. Deuel, professor of physiology at the University of Maryland, to the professorship in biochemistry.

DR. CHAS. GURCHOT and Miss Frances Watson have been appointed research assistants in the department of pharmacology and the division of neurology of Stanford University School of Medicine, assisting in researches on syphilis supported by a grant from the Committee on Research in Syphilis to Dr. P. J. Hanzlik and Dr. H. G. Mehrtens.

R. KEITH CANNAN, senior lecturer in biochemistry at University College, London, will give two courses this summer at the school of medicine of Western Reserve University under the auspices of the summer session. In addition to conducting a brief course in biochemistry, he will give a series of lectures upon "Biological Oxidations and Reductions."

SPECIAL CORRESPONDENCE

THE GENEVA SUMMER SCHOOL OF ALPINE GEOLOGY[1]

LED by Professor Léon W. Collet, professor of geology at Geneva and Harvard universities, with the collaboration of his chief assistant, Dr. Ed. Paréjas, a group of British and American geologists, including Professor and Mrs. Kirtley Mather, of Harvard University, and their party of eleven students, spent a memorable three weeks during July of the past summer, in the study of Alpine geology in the field, going on foot with rucksacks through the high mountains and traveling along the valleys by motor and train. The course included a study of the Alpine foreland, which comprises the Jura Mountains, the Swiss Plateau, the High Calcareous Alps (the Morcles, Diablerets and Wildhorn Nappes) and the crystalline massifs of the Aiguilles Rouges, Mont Blanc, Gastern and Aar. The latter part of the three weeks was spent in a study of the geosyncline south of the foreland, which is represented by the Simplon, Saint Bernard, Monte Rosa and Dent Blanche Nappes. The hinterland, which was not studied in the field, forms the southern boundary of the Alps. It is the southern jaw of the vice, which has approached the northern one (the foreland) to produce the intense folding and thrusting of Alpine structures. For the follower of Wegener, the hinterland is, of course, Africa or Gondwanaland. (A portion of the hinterland which was thrust over the geosyncline and the foreland is represented in the west by the Prealps and in the east by the Austrian Alps.)

Starting from Geneva the party first crossed the Swiss Plateau where the Molasse, a thick series of Tertiary sandstones and conglomerates, was deposited at the northern foot of the then still growing Alps, whose advancing nappes finally overrode the southern edge of their own débris. Forming the northern rim of the plateau are the Jura Mountains, which lie in a great arc to the northwest of the Alps. They are, indeed, but a branch or virgation from the bow of the western Alps, having been formed by the northward push of the nappes. Here the party saw the steeply folded, underthrust, asymmetrical, pitching and faulted anticlines so characteristic of Jura structure. These structures become even more interesting in the light of Buxtorf's discovery that the crystalline rock of the substratum, the Permian and even the oldest strata of the Trias have remained undeformed beneath the crumpled structures of the Jura. These folds of the Jura have been developed upon the lubricating salt-bearing shale beds of the middle Muschelkalk which lie at the base of the folds. The deformed beds have thus suffered a *décollement* over the basement rocks.

Other features of great interest in the Jura were the tear faults, approximately vertical zones of more or less nearly horizontal movement, cutting across the strike of the folds and diverging to the north.

[1] In this very brief résumé, no effort has been made to cite references. For an excellent account of the geology of the Alps the reader is referred to Professor Collet's book, "The Structure of the Alps" (London, Edward Arnold Co., 1927), which contains also complete bibliographies.

By this displacement, whose effect on the topography is often striking, an elongation of ten kilometers in the arc of the folded Jura has been produced.

Leaving the Jura and passing southward from Geneva to cross the Prealps and the ranges of the High Calcareous Alps, the party made the ascent from Chamonix to Montenvers, in the Mont Blanc massif, that magnificent and ancient range which dominates the scenery of the western Alps. Long before the birth of the Alps, it had passed through the throes of Hercynian mountain building whose record it still carries in the north-south orientation of its schists and of the inclusions and phenocrysts of its granite. Standing submerged in the early Mesozoic at the northern border of the Alpine geosyncline, it received a cover of shallow water limestone of Triassic and Jurassic age. Forming a part of the foreland, which was the northern jaw of the vice in which the sediments of the geosyncline were compressed to become the nappes[2] or recumbent anticlines of the Pennine Alps, the Mont Blanc massif was caught in the convulsive northward movement of the Oligocene. At this time the entire crystalline massif was thrust toward the north, splintering into a multitude of wedges and slices while its sedimentary cover was thrown into a series of northward-traveling folds. The massif was itself overridden by the Pennine Nappes, which rose from the geosyncline to the south, and was finally reexhumed by erosion to occupy the dominating position which it holds to-day.

Crossing again the zone of Chamonix, which separates the Mont Blanc from the Aiguilles Rouges, the party mounted to the plain of Salenfe, the floor of an enormous glacial cirque eaten into the heart of the Aiguilles Rouges massif. Here the granites and schists of the massif itself are overlain by the Trias of the autochthon or original sedimentary cover. Lying above this and separated from it by a thrust plane is a great recumbent anticline with Tertiary rocks at the base of the reversed limb, Middle Jurassic at the core and Upper Jurassic at the top. It is a part of the frontal fold of the Morcles Nappe which has traveled northwestward from the zone of Chamonix along the clean-cut thrust at its base. Into the core of this nappe the upper portion of the cirque of Salenfe has been carved, exposing the grandest features as well as the most minute details of its structure in the precipitous slopes of the Tour Saillere, which stands out in the morning sunlight like an enormous text-book diagram. Along the thrust plane of the nappe, lying between the nappe and the autochthon, one may observe in places a discontinuous layer of mylonite, the remnants of masses of gneiss which were torn from the crystalline basement by the moving nappe, and completely crushed and granulated as they were dragged along beneath it.

From Salenfe the party returned to the zone of Chamonix, and thence traveled eastward along the strike of the Morcles Nappe. They saw it pitching beneath the Diablerets and Wildhorn Nappes, higher elements of the High Calcareous Alps, and reappear with the axis elevation to the eastward, rising over the Gastern Massif, which corresponds structurally to that of the Aiguilles Rouges farther west.

From the Torrentalp above Loèche-les-Bains the party climbed to the Nieven pass in the zone of the Lötschenthal, which represents the eastward prolongation of the zone of Chamonix. On the way to the pass they saw, rising against the sky in four huge saw-toothed ridges, the four crystalline wedges whose upward and northward drive into the overlying limestones and shales had started the Morcles Nappe on its journey over the Gastern Massif, developing in the nappe the four recumbent frontal folds which are exposed in a single spectacular cliff immediately north of the wedges. Lying in the passes between the crystalline ridges are the remnants of the overturned synclines which lay between the forward-driving masses of crystallines. To see here the zone of the roots of the nappe where the crystalline wedges stand in such clear relationship to the sedimentaries of the synclines between them and to the recumbent folds of the nappe in front of them, was to feel oneself a witness to the very building of the Alps, so plainly are the tectonic features exposed in the scenery.

From the Lötschenthal the party climbed northward over the Gastern Massif and descended by the Tschingel Glacier to Lauterbrunnen at the foot of the Jungfrau mass. From Lauterbrunnen to the Rottal Hut of the Swiss Alpine Club the trail led over the foot of the limestone slopes of the Jungfrau group, which rests on the crystalline rocks of the Gastern Massif. At the base of the limestone series are the yellow, the red and the black beds of the gently dipping Triassic, followed by the gray and the brownish rocks of the Jurassic. This is the normal series of the autochthon, resting on the crystallines with a sedimentary contact. Climbing higher, one again perceived yellow limestones of the Triassic, and above them beds of the Jurassic, which belong to a second normal series exactly like the first and rest upon it with a mechanical contact. This duplication within

[2] A true nappe is a recumbent anticline whose reversed limb has partly disappeared owing to stretching. The term is applied also to recumbent anticlines such as the Pennine Nappes.

the autochthon is a common feature, caused by the northward thrusting of the overriding nappes and wedges which dragged slices of the autochthon beneath them and piled them up where local conditions permitted.

Penetrating into these piled-up limestones is an enormous wedge of crystallines originating from the underlying Gastern Massif. It is covered by a layer of limestone and by a zone of gneiss, intensely crushed and mylonitized, which wraps around it. Above the autochthon may be seen the gray wall of the Morcles Nappe, a quite different tectonical element which has come from the south. In this, the Cretaceous, lacking in the lower series, is present, denoting that sedimentation in the site of deposition to the south was different from that which occurred on the Gastern Massif, the place of origin of the autochthon.

At the summit of the Jungfrau mass, the granites which have been thrust up over the nappe from the south are revealed in the ruddy hues of the peaks. Here again one sees with startling clarity the structure of the mountains; the Gastern crystallines of the basement of the Jungfrau; their original sedimentary cover, sliced and stacked up in repeated series; driven into these a huge crystalline wedge, and driven over them the sedimentaries of the Morcles Nappe; and capping it all, that amazing mass of granite which has ridden up over the nappe itself to form the summits of the range.

Striding over the ground covered by the party in the trip from Lauterbrunnen to Zermatt in the region of the Pennine Nappes of the geosyncline, we leave the massifs of the foreland and the Morcles Nappe, itself a part of the foreland, and pass directly to the geology of the geosyncline, that portion of the ancient sea of Tethys which was the birthplace of the Alps. Among the most interesting of the differences between the rocks of the High Calcareous Alps of the foreland and those of the Pennine Nappes of the geosyncline is in the character of the sediments. While those of the foreland are predominantly limestones of shallow water and reef types, those of the geosyncline represent a deep-water facies. Indeed, radiolarites associated with manganese ores occurring in the youngest of these deposits, the *Schistes lustrés*,[3] are so similar to certain deep-sea deposits of the present day that they are supposed by Alpine geologists to represent a true abyssal facies. In equally striking contrast to the nature of the rocks of the Morcles Nappe is the relatively high grade of metamorphism which characterizes the material involved in the folding of the Pennine Nappes. And yet ammonites have been found in these rocks, even in garnetiferous zones of the *Schistes lustrés*.

From the Gornergrat, above Zermatt, the geologist sees a magnificent panorama of the uppermost of the Pennine Nappes: the Saint Bernard, the Monte Rosa and the Dent Blanche. Two of these, the Saint Bernard and the Dent Blanche, have existed since Carboniferous time as geanticlines which rose, early in their history, above the level of the geosynclinal sea. About the shores of these embryonic nappes coarse breccias and conglomerates were deposited while the *Schistes lustrés* were being laid down in the deep water of the synclines. The development of these nappes was, then, only the culminating event of a history which was amazingly long, even in terms of geological chronology. Throughout Mesozoic times the embryonic nappes continued to grow, becoming more and more strongly overturned, until finally, in the paroxysmic folding of mid-Oligocene times, they started on their northward journey and became the dominant elements in the structure of the geosyncline. Thus the lower nappes of the geosyncline, the Simplon assemblage, were set in motion by the Saint Bernard, and the Monte Rosa group by the Dent Blanche Nappe.

At the base of the Dent Blanche Nappe, in the Unter Gabelhorn, was observed one of the most interesting of the details of Alpine geology. Here a sill of gabbro eighty to one hundred meters in thickness has been intruded along the thrust plane and suffered terrific crushing under the moving nappe. One is immediately reminded of the "Sima" of Wegener's hypothesis.

From the Gornergrat, above Zermatt, the observer also has a splendid view of the remnants of an ancient mature valley six to seven kilometers wide, whose uplift, amounting to about twenty-five hundred meters, represents the most recent of major Alpine movements, having occurred at the beginning of the Quaternary.

At Zermatt the course ended, leaving its participants breathless at the magnitude, not only of Alpine structures and the movements which they represent, but also at the colossal piece of physical and intellectual work which has been done by the geologists who have unraveled the story. And no less breathtaking is the magnificence and completeness of the exposures, and the certainty with which major structures may be worked out in three dimensions, once the stratigraphy is grasped. One never need dig in rabbit-holes in the Alps!

RUTH ALLEN DOGGETT

RADCLIFFE COLLEGE

[3] The French word *schiste* is, like the German *Schiefer*, applied to any rock possessing marked fissility and does not necessarily denote one of metamorphic origin.