looking for discussion of the subject indicated by the major title, "Structural Geology," has therefore no ground for disappointment if he finds but scant consideration given the topics usually comprised under that head.

The treatment in this volume of four hundred and odd pages is purely descriptive. This being the method, approximately two thirds of the space is given to illustrations, which are well selected and well reproduced, and but one third or less to the very brief text.

Primary structures of sedimentary and igneous rocks are described in the first 100 pages. Stratification, interbedding, reefs, talus, placers, glacial drift and "characteristics of sedimentary mineral deposits" are curiously associated with elementary illustrations of structures. The important subject in quotation marks above is dismissed in two thirds of a page of text. Under igneous rocks we find a brief list of intrusive and extrusive forms, supplemented by 10 pages of description and 30 pages of illustration. The text and illustrations relating to orogenic movements occupy 4 pages. Next comes a chapter on folding, 62 pages, and another on faulting, 91 pages, in which the structures are described in considerable detail, but not analyzed as to possible conditions of stress and strain. The omission of any discussion of mechanical principles as applied to rock deformation is in the opinion of the reviewer to be regretted by engineers, since it is of vital importance in mining operations.

We have now reached the last third of the volume. In the few pages given to partings in rock masses joints and cleavage are used as synonymous terms. The confusion of thought suggests the almost forgotten controversy between Van Hise and Becker. Under the heading "Veins" two major classes are distinguished, namely "endokinetic" and "exokinetic." The subject is treated in 7 pages of text with 33 of illustrations. The latter part of the work comprises an account of structures in folded and faulted regions, with emphasis on European interpretations and some repetition of earlier chapters. The remaining items are: Igneous activity and mineralization, 1 page; surveying and mapping, 16 pages including illustrations, geophysical methods, 21 pages; influence of structure on mining, 17 pages; glossary, bibliography and index.

The writers of this book are eminent in their profession, both in teaching and practice. Their careers have been long and successful. But their contemporary in reviewing their work is reminded of the geologic dogmas of past decades, before the masters of geology in America challenged them and aroused the critical and progressive spirit of inquiry that characterizes our scientific attitude to-day. Having consulted a number of teachers in eastern and western universities the reviewer believes that he expresses a consensus of opinion in saying that the text is inadequate and elementary, but some of the illustrations will be found to have significant value for those who seek examples, especially of ore deposits.

BAILEY WILLIS

SPECIAL ARTICLES

BRAIN POTENTIALS DURING HYPNOSIS

IN a previous communication we have distinguished three types of waves (rhythmic electrical potentials) which could be recorded from electrodes placed on the head of a normal adult person.[1] For convenience of description and because of their characteristic appearance, we have named them as follows: (a) "Trains." These appear as trains of waves lasting from 1 to 30 seconds. Their frequency for each individual appears to be relatively characteristic, usually about 10 per second. They were first described by Berger[2] and are called by Adrian[3] the Berger rhythm. (b) "Spindles." These appear only during deep sleep, usually last less than a second, and are not nearly as numerous as the trains. Their usual frequency is about 14 per second. (c) "Random." These are irregular potential waves with no characteristic frequency appearing during sleep.

When a person is going to sleep the trains persist for some time, but become less and less frequent when drowsing, gradually changing over to the random type. After some time the spindles usually begin to appear. The spindles are so characteristic of some individuals that their occurrence has been accepted as an objective criterion of deep sleep. If the subject is disturbed, the spindles immediately cease and the trains usually appear at once.

In order to compare hypnosis with sleep, one of our subjects was studied under hypnosis. He was brought to the laboratory by Dr. David Slight, of McGill University, Montreal. The subject had been hypnotized many times before. He was first tested awake and during normal sleep and showed characteristically normal trains of 9.9 per second and spindles of 12.5 per second frequency. After Dr. Slight had induced the hypnotic state, a sustained condition of cataleptic rigidity ensued. Nevertheless, the trains characteristic

[1] Loomis, Harvey and Hobart, SCIENCE, 81: 597, 1935; 82: 198, 1935.

[2] Berger, *Arch. f. Psychiat. u. Neur.*, 1929–35.

[3] Adrian and Matthews, *Brain*, 57: 355, 1934; Adrian and Yamizawa, *Brain*, 58: 323, 1935.

of a person awake remained at all times during hypnosis and no spindles or random waves (characteristic of normal sleep) appeared during any of the tests. It would seem that the term hypnotic "sleep" is not a correct one for the hypnotic state, at least as measured by this criterion.

The "trains" of waves, with their characteristic frequency appear in normal subjects most regularly and continuously when resting quietly and comfortably with eyes closed and the "mind at peace." Opening the eyes stops the trains if the room is not completely dark. If the eyes are kept open continuously in a dark room trains will appear and disappear as a minute point of light is flashed off and on. This light may be so faint that it can only be seen with thoroughly dark adapted eyes.

We wished to test whether it was possible to produce and record temporary blindness induced by hypnotic suggestion. The subject's eyelids were fastened open with adhesive tape and he was hypnotized. After giving the subject careful instructions, Dr. Slight suggested alternately every 15 seconds that he could see and that he was blind. This was repeated a large number of times. In every case trains appeared when the suggestion was made that he was *blind,* and in every case they ceased when the suggestion was made that he could *see.* This was true both when there was a light in the room and when the room was in total darkness.

The trains of a normal person, unhypnotized and who never had been hypnotized, tested in a completely dark room, will stop if it is suggested that he sees something, a light or a face. We have never been able to start trains by suggesting to a non-hypnotized subject that he sees nothing when his eyes were open in a light room.

Emotional disturbances, such as extreme embarrassment or anxiety and apprehension, will usually stop the trains. Adrian has suggested that these waves should be absent in a blind person. He believes that he had confirmed this conclusion on three subjects that had been blind for some years. Our interpretation of these results is that these blind persons were emotionally disturbed because of the strangeness of the tests. We have found that many persons before they have become accustomed to the electrodes and their strange surroundings, show few or no trains during the first hour or so.

One of our subjects had been blind since birth. When he was first tested, practically no trains were evident. Later in the day, when the subject was thoroughly at ease and after he had confessed that he was no longer apprehensive, regular trains appeared until he had been asleep for some time, when the waves became random followed by the characteristic "spindles." While asleep, a cough outside the room (which he remembers hearing and which evidently slightly awakened him) again gave rise to continuous trains lasting for six minutes. Such behavior is quite characteristic of a person with sight, and in no way have we found the potentials of this blind subject to differ from a normal person. The frequency of his trains were 11.7 per second. His spindles were 14.5 per second.

It is not possible in this brief note to give proper credit to the findings of Berger,[2] Adrian,[3] Kornmüller,[4] Jasper,[5] Davis,[6] and others, but an adequate explanation of the "trains" must take into consideration the following characteristics which we have observed and to which we direct special attention. Twenty-eight different persons have been studied, all for at least 2 hours, one for an aggregate period of 50 hours.

(1) *Variability.* A marked difference among normal adults in regard to the appearance of these trains. Under the most favorable conditions, and considering a period of an hour, we have seen subjects where trains were present at least 90 per cent. of the time, and other subjects where only a few bursts occurred during this time, and still others in which no trains appeared, although different frequencies might be present.

(2) *Age.* We have never seen them in babies. Three babies, ranging from 17 to 126 days old, gave only random potentials. In young children the tendency is for low frequencies to appear. Two identical girl twins 27 months old gave records identical in general character with large "saw tooth" potentials of 4 to 5 per second, whereas a girl 28 months old from another family gave a very different type of record with 7 to 8 cycle potentials. Boys 4 years old gave 8.5 cycle potentials and boys of 15 years gave records similar to adults. Trains were well marked in a man of 74.

(3) *Regularity.* Trains are so regular in their phase and frequency in some persons that a sharply tuned amplifier responds well to them. We have found the use of an amplifier tuned to particular frequencies very convenient for picking out rhythms otherwise obscured by superposed waves which show in the record from the untuned amplifier.

(4) *Change in frequency with rest.* In every case where we have had a subject lying quietly for two hours or more, the frequency of the trains was from 5 per cent. to 10 per cent. slower at the end of the period than at the beginning.

[4] Kornmüller, *Biol. Rev.,* 10: 383, 1935.

[5] Jasper and Andrews, *Jour. Gen. Psychol.,* 14: 98, 1936.

[6] Gibbs, Davis and Lennox, *Arch. Neur. and Psychiat.,* 34: 1133, 1935.

(5) *Disturbance.* When the trains are appearing almost continuously they nevertheless are interrupted every few seconds by some sort of disturbance. This disturbance may interrupt the trains coming from one part of the head without stopping those from another part.

(6) *Mental activity* as such does not seem to affect the trains. A person may be read to, converse or do *simple* problems in mental arithmetic, without affecting the trains.

(7) *Emotional states* seem to have a profound effect upon the waves. If a subject is embarrassed or apprehensive practically no waves appear. The trains can usually be stopped if a subject is asked to solve a difficult problem in the shortest possible time (that is, if he becomes "rattled"). One subject could stop his trains at will by imagining himself in a terrifying situation (a phantasy of fear).

(8) *Effect of light.* The appearance of light stops the waves in 0.1 to 0.2 second. Seven tenths seconds or more may elapse before they again start after the light disappears. This influence of light is certainly not a direct effect but rather a secondary one, for the following reasons. If the eyes are kept open continuously and the subject is lying quietly in a lighted room, a few trains will usually appear after a time. On the other hand, if the subject is lying in a completely dark room and a faint light has been flashed on and off several times at regular intervals, then if he is told that the light will be flashed on, the trains will stop, even though the light is not flashed on. This effect is best seen (with the subject in a dark room) by simultaneously turning on a light and sounding a tone at regular intervals. After a time the sounding of the tone alone will stop the trains, although before this "conditioning" the tone alone has no such effect. In the case of a hypnotized subject the converse was also true, *i.e.*, the trains would start up at once when he was told he could not see the light, even though it continued to shine directly into his eyes.

(9) *Flicker.* We find, as does Adrian, that flickering lights give rise to potentials in some persons that exactly follow the flicker frequency over a limited range. Occasionally the brain response will be double the flicker frequency. In one subject who showed unusually regular trains no flicker frequency could be induced.

(10) *Sleep.* As a subject is going to sleep the trains appear regularly, but they cease after a time during deep sleep. And yet they will immediately appear if the subject is disturbed. Noises, etc., that the subject is accustomed to hear during sleep, such as the blowing of an automobile horn, do not necessarily have any effect, but anything that indicates that another person is near almost always produces a marked effect with the immediate appearance of the trains. Thus, a faint cough, a whisper, faint footstep, rustling a piece of paper, have all produced trains when loud noises and bright lights have failed. We are inclined to believe that this starting of trains by sound is not a direct result of the sound stimulus but is connected with a change in the general level of brain activity.

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LEAF XANTHOPHYLLS

As a result of the improvement of methods for the isolation of carotenoids, it has been found that leaves contain not less than twelve, and probably more, xanthophylls. Many of these are very soluble in aqueous alcohol and are not recovered from the dilute alcoholic solutions employed in the partition and crystallization methods of Stokes and of Willstaetter. Several of the xanthophylls are adsorbed with the chlorophylls upon Tswett columns and, under the conditions previously employed, are not observable in the presence of the green pigments. Others occur in such small amounts that they can be detected only by the use of Tswett columns composed of very active adsorbents.

In order to demonstrate the presence of such a great number of xanthophylls in leaves, it has been necessary to develop methods for the isolation of all the xanthophylls free from other leaf constituents. This mixture of xanthophylls is then separated by adsorption upon Tswett columns. The successful application of the latter method has been due to the selection of highly active adsorbents which do not decompose the plant pigments and to the availability of a number of solvents which may be used to vary the quantity of pigment held by the adsorbent.

When leaf xanthophyll, prepared by the improved method, is adsorbed upon Tswett columns, three or four pigments pass rapidly through the column. These pigments resemble Cryptoxanthin with respect to solubility and to partition between immiscible solvents. They are followed on the column by lutein, which comprises somewhat more than half the recoverable xanthophyll. The lutein is followed by a pigment not previously described, for which the name "isolutein" is proposed. The isolutein is optically inactive, its absorption maxima are twenty Ångström units toward the violet from those of lutein and, in contrast to lutein and zeaxanthin, its solutions in ether exhibit a deep blue color when treated with concentrated hydrochloric acid. Zeaxanthin, which is present in small