4 percent of the surface has membrane thickenings, a condition suggestive of chemical synapses.

While neuroglial cells were a recurrent subject of discussion, they were the principal theme of two contributions. S. W. Kuffler (Boston) reported integrated electron microscope and electrophysiological and tracer studies of the giant glial cells in the leech. Here the glial resting potentials are at least as large as those of neurons and are similarly dependent mainly on a high internal K^+. They do not give active responses to stimulation or demonstrate marked drops in their normally high resistance. They are not essential for the short-term survival of neurons which continue to give normal impulses when glial cytoplasm surrounding them is removed. While there is little current spread between glial cells and neurons, current spreads readily from one glial cell to another. The important conclusion is that not the glia, but the narrow intercellular spaces which resemble those in vertebrates must be the path for the rapid diffusion of K^+, Na^+, sucrose, choline, and other small molecules; these substances can be shown to reach nerve cells without first passing through the glial cells. Kuffler calculates that if these spaces are 50 A or more, there should be no serious restriction on the movements of such molecules. R. Galambos (New Haven) reviewed the diverse sources of evidence concerning the physiological role of glial cells. He emphasized their participation in myelination and demyelination and their chemical changes with respect to RNA during learning in rats.

Earthquake Prediction

Research related to earthquake prediction was the subject of a conference held in Tokyo, Japan, 9–20 March 1964. The general tenor of the conference was that, while specific earthquake predictions are not now possible, a number of promising lines of investigation offer the hope that at some time in the future fairly detailed predictions can be accomplished. The lack of a satisfactory technique at present was demonstrated rather graphically after the conference when, without warning, a large earthquake devasted much of southcentral Alaska.

Generally speaking, the matter of earthquake prediction is taken much more seriously in Japan than in the United States where mention of the subject frequently draws comments of derision or hopelessness. Most Japanese think of the earthquake as one of a sequence of events, some of which precede the main shock and have properties which may very well be measurable and indicative of the earthquake to follow. Some Americans, on the other hand, tend to associate the term "earthquake prediction" with various schemes in the realm of astrology, or numerology, or some other form of mysticism or occultism, and thus overlook the possibility that sound scientific principles can be applied to the problem with some hope of success. The relative seismicities of the two countries must affect these attitudes; nearly all Japanese are continually reminded of the problem, while most Americans are not. The participants in this conference approached the problem with the gravity and thoughtfulness it deserves.

The opening session on the subject of general considerations was chaired by K. Wadati and a vigorous discussion, led by C. Tsuboi, developed and separated the optimists from the pessimists. It was pointed out that earthquake prediction is now a fact in the sense that we can predict where, although not when, most large earthquakes will occur. In response to the question of what sort of prediction is desired or required, two basic kinds of prediction evolved. One concerns the probability that potentially destructive earthquakes will occur in a given region, together with estimates of their effects, so that locations for man-made structures may be chosen wisely and the structures designed appropriately. Times of the order of the life of the building are of interest here and property damage is a principal concern. Much progress has already been made along these lines in certain areas. A second desired type of prediction would foretell the time of a large earthquake in a given area within minutes, or hours, or even days so that personnel might take proper precautions and injury or loss of life could be prevented. Less accurate predictions are also valuable; emergency supplies might be stored, for example, in areas where a shock is expected within months.

Many felt that prediction techniques might not be generally applicable; that is, one technique might work in one area, and a different technique might be suitable for another area. A parallel with the case of volcanic eruptions was demonstrated. Eruptions are now reasonably well predicted for a few volcanoes whose habits are well known, although different in each case. Because the relatively infrequent occurrence of destructive earthquakes in a given area may not provide sufficient data for thorough study by seismologists, it was emphasized that collection and storage of data must be done wisely now in order to provide the best possible information for succeeding generations.

In a session on crustal deformations measured by geodetic surveying, discussions centered on the past and proposed extensive triangulation and leveling surveys carried out in Japan on a scale rarely contemplated and never carried out in the United States. The value of such surveys was clearly demonstrated by numerous examples related to Japanese earthquakes. In fact, some well documented cases were reported where Japanese citizens without the aid of instruments made observations just prior to the shock of striking land deformation. Special leveling and triangulation surveys of the Mitaka Rhombus, a small-scale set of fixed points, showed deformation just prior to earthquakes. Emphasis was placed on the difference between California earthquakes and Japanese earthquakes. Movement in the former is largely horizontal, while movement in the latter is more often vertical.

Crustal deformations measured by tide gauges, strainmeters, and tiltmeters were discussed. One serious difficulty in all such measurements is that effects on the instruments by tectonic movements must be separated from those due to meteorological and oceanographic effects. There was discussion of the question of rate of strain accumulation; some feel it is rather uniform, others feel that it is somewhat sporadic. It was generally agreed that strain accumulation varies from place to place even in the same tectonic zone, such as the San Andreas rift zone. Related to this is the question, unanswered at this conference, of whether small shocks in an area mean strain relief or strain accumulation. While data on measurements of secular strain are sparse and generally not very reliable, the upper limits for secular strain in Japan, California, and New Jersey correlate well with the degree of seis-

mic activity in the respective regions. Some new instruments for measuring these deformations were described and the need for an instrument to measure precisely long-term changes in water levels in off-shore areas was emphasized; many shocks occur near coastlines and important data could be collected in this manner.

In discussions on seismicity, Suyehiro and Asada made an interesting point based on data on microearthquakes. In the one case for which data are available, foreshocks could be identified by studying their frequency of occurrence as a function of magnitude. This factor could be an important point for earthquake prediction if borne out in subsequent studies. K. Mogi described his laboratory experiments on microfractures associated with rock failure in specimens with various degrees of heterogeneity and attempted to relate his results to data on microearthquakes. This work shows considerable promise.

The statistics of seismicity, harmonic analyses of the time series, relation between seismicity and gravity anomalies, seismicity and heat flow were all covered. Most of the data originated with researchers from Japan. A quantitative statistical prediction of earthquakes in Japan was presented in terms of the probability of an earthquake occurring in the near future. This probability increases regularly with time until a shock occurs.

A number of Japanese scientists discussed geomagnetic effects associated with earthquakes; some found promise for earthquake prediction in this work, which is on a subject rarely pursued in the United States. Benioff's negative results, based on limited and restricted observations from California, comprised the only United States report. There is a need for observations near the epicenter, and such data are difficult to obtain.

The relation between earthquakes and geological observations in various parts of Japan was reported in some detail. In some areas geologic data agree reasonably well with results on crustal movements deduced from earthquake activity; in others the relation, if any, is not clear. In Japan the major active faults strike perpendicular to the trend of Honshu Island and the motion is left-lateral. This is in contrast to the case in California where the major faults parallel the trend and motion is right-lateral.

Field trips during the conference included visits to the Tsukuba and Nokogiriyama seismic stations in the Tokyo area, the Matsushiro station near Nagano, and the Abuyama and Osakayama stations near Kyoto. Much of the Japanese instrumentation at these stations is, of course, directed toward the study of local earthquakes. There are many strainmeters and water tube tiltmeters, in addition to more conventional seismographs. All of the vaults for the stations listed, with the exception of Abuyama, are in tunnels or rooms cut into the hard rock of a hill or mountain. The American participants were, of course, well aware, prior to the meeting, of the Japanese proficiency in geophysics, particularly in the field of seismology. However, all left Japan with an even higher regard for the work of their colleagues in that country and with a feeling of gratitude for their most kind hospitality as hosts for this conference.

The Japanese delegation included C. Tsuboi, K. Wadati, T. Hagiwara, K. Tajime, Y. Kato, S. Miyamura, I. Ysubokawa, K. Iida, E. Nishimura, T. Hirono, and H. Kawasumi. The United States delegation consisted of H. Benioff, R. Hanson, L. Knopoff, J. Oliver, J. Steinhart, G. Sutton, and D. Tocher. In addition two other Americans, C. H. Dix and R. Oetjen, and about 40 Japanese participated in the program. Unfortunately, one delegate, E. Nishimura (Kyoto University), who had participated enthusiastically in the program planning, became seriously ill just prior to the conference and died the day before it ended.

The participation of the United States was supported by the National Science Foundation. This conference was one of the approximately ten annual bilateral scientific seminars convened under the U.S.–Japan Cooperative Science Program for which the National Science Foundation's Office of International Activities bears administrative responsibility in the United States. A complete summary of the conference will be published in Japan in about 6 months. Copies will be available on request from T. Hagiwara, Earthquake Research Institute, Tokyo University, Tokyo, Japan, and Jack Oliver, Lamont Geological Observatory, Palisades, New York 10964.

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Solid-State Physics

The first of what may become an annual series of conferences on solid-state physics was sponsored by the Institute of Physics and the Physical Society at Bristol, England, 1–4 January. Four hundred scientists from Great Britain and from nearly 20 other nations attended.

The papers represented most of the currently active areas in solid-state physics, including metals, semiconductors, defects, and magnetism. A. B. Pippard (Cambridge University) opened the conference with an invited paper in which he suggested that the recent preoccupation with structure by metals physicists is giving way to a concern with function. He noted that the intensive study during the past few years of the band structure and Fermi surfaces of metals was made possible by the discovery of new phenomena, such as the Azbel'-Kaner cyclotron resonance, and by the proper understanding and wide application of more venerable phenomena, such as magnetoresistance, but that such study is now being supplemented by an increasing interest in the phenomena themselves. He illustrated his point by discussing longitudinal magnetoresistance in metals, such as copper, with multiply connected Fermi surfaces. This effect does not give direct structural information about the Fermi surface but is an example of an effect for which the usual theory, based on the Boltzmann equation with the relaxation time assumption, is qualitatively incorrect. He showed how the observed behavior might be understood and how it might be used to study the details of the scattering process in metals.

These two aspects of current work in the physics of metals, which might be called Fermiography and phenomenology, were further exemplified in two papers. D. Shoenberg (Cambridge University) described a new technique for studying the de Haas-van Alphen effect and its application to the alkali metals. With this technique, fractional deviations from sphericity of the nearly spherical Fermi surfaces of these metals as small as 10^{-3} could be measured. The accuracy of the results permitted a very precise comparison with the theoretically computed Fermi surfaces; there was disagreement between surfaces computed experimentally and theoretically in respect to both the size and shape of the deviation