Geology of the John Day Basin.' The igneous rocks of pre-Eocene age comprise quartz-mica diorite, serpentines and pyroxenite. The Tertiary series, including the fossil-beds, is almost entirely composed of volcanic materials. The Clarno Eocene began with the eruption of andesitic lavas and tuffs, followed by quartz-basalt and rhyolite. The John Day Miocene beds are mainly tuffs of trachytic and andesitic character. Upon them lie the great basalt series, which is in turn overlain by the Mascall beds, similar in general composition to the John Day. The Pliocene Rattlesnake formation comprises rhyolitic lava and tuffs. The most recent evidence of volcanic activity consists in ash-beds interstratified with the terrace gravels.

Colemanite: ARTHUR S. EAKLE, Berkeley, Cal.

The paper contains the results of a crystallographic study of a large number of colemanite crystals from the Calico district, San Bernardino, Cal. The crystals are exceptionally rich in forms and in the number of well-developed faces. Although only showing terminations on one end of the vertical axis owing to their attachment to the matrix, seldom less than twenty faces are present, and some of the combinations if completed would show upwards of one hundred faces. About fifty forms occur, of which one third are new. Four quite distinct habits are noticeable, governed by the absence or predominance of certain of the terminal forms. The measurements were made with the two-circle goniometer designed by Goldschmidt, and since this important method is comparatively new to the mineralogists of this country, a detailed description of the work is given, in order to make clear the method of calculating and projecting the forms. The figures accompanying the paper are a gnomonic projection of the forms, an orthographic projection on the base and several clinographic projections illustrating the varied habits and combinations observed.

Eocene and Earlier Beds of the Huerfano Basin, Colorado, and their Relation to the Cretaceous: R. C. HILLS, Denver, Colo.

The paper discusses the stratigraphical and structural features of the Huerfano Eocene, and associated Upper Cretaceous beds, for the purpose of correcting certain errors that appeared in earlier papers on the subject. The uppermost beds previously assigned to the Eocene have been shown to contain a Wind River and Bridger fauna, but there is a much greater thickness of conformable beds of similar character, the age of which has not been definitely established, which it is thought should be provisionally correlated with the Lower Eocene of the Uinta and San Juan basins. The Lower or Poison Canyon formation is found to be unconformable with the true Eocene and with the underlying Cretaceous, and to present a strong contrast with the latter lithologically. It is suggested that the Poison Canyon beds are nearly related to, if not identical with, the post-Laramie formation of the Denver Basin.

ANDREW C. LAWSON,
Secretary.

A NEW BAROMETRY FOR THE UNITED STATES, CANADA AND THE WEST INDIES.

A NEW system of reducing the barometric observations of pressure at the stations of the Government Services of the United States and Canada was put in operation on January 1, 1902. The Weather Bureau has received all the data necessary for carrying on the Canadian computations simultaneously with its own, through the courteous cooperation of Professor R. F. Stupart, Director of the Canadian Meteorological Office. The reduction of pressures observed on the Rocky Mountain plateau to sea level is a problem of great scientific difficulty for two reasons: (1) Because it is not evident what the exact effect of the plateau is as modifying the ordinary Laplacean free air reduction, even when the mean temperature of the air column θ is assumed; and (2) because the vertical temperature gradient between the observed surface temperature t and the sea-level temperature t_0 is difficult to determine, or in other words because the connection between $\frac{1}{2}(t+t_0)$ and the true θ is hard to find. The solution of this problem has been forced upon the Washington Office ever since the opening of the service in 1870, inasmuch as the results of such reductions are used to form the daily weather maps, and the errors of reduction result in inaccurate systems of isobars, and consequently incorrect deductions regarding the existing weather conditions, especially west of the Mississippi Valley. The perplexity of the problem may be inferred from the fact that the present system constitutes the sixth effort to solve it. The indications are that the new isobars conform very closely to the true weather, and that the practical working of the system will prove to be satisfactory to the Bureau.

A brief summary of the earlier methods of reduction is as follows:

1. For the years 1870–81 all the low stations were reduced by an elementary application of tables given in Loomis' 'Meteorology' (the same as Guyot's table D, XVI., edition of 1859), using the temperatures observed at the moment of observation. 1872–1880. The higher stations were not reduced except by the application of a constant appropriate to the mean annual temperature and pressure; the lower stations continued with the elementary method, but this included an erroneous use of the observed pressure.

2. 1881–85. The Abbe-Upton system of monthly constants for each station, based on the mean monthly temperatures and pressures.

3. 1886–1887. Ferrel's system was in operation but found to be in a form which was too complicated for practical station work. However, some correct principles were introduced by him, namely, the mean temperature of twenty-four hours as the argument instead of the temperature at the time of observation; a separate correction for the plateau effect; the variation of the reduction with the local pressure; and a correction of the surface temperature t to the mean θ by an approximate vertical gradient.

4. 1888–1890. A mixed system, partly Ferrel's and partly Hazen's. 1891–1901. Hazen's empirical system alone, in which numerous changes were made in the wrong direction. The plateau correction was omitted, the pressure argument was abandoned, and the surface temperature not corrected to θ became the only argument. In constructing the empirical tables it was assumed that Mt. Washington is a correct type for the plateau effect, which is not true; the pressure on the sea level was taken as exactly 30.00 inches in working out the reductions, which does not conform to the facts; the check upon the reduction was limited to the criterion that the isobars could be smoothly drawn, and reductions for many stations received arbitrary modifications for that purpose. The result of this system was to give too high sea-level pressures at low temperatures, especially in cold waves, and too low pressures in warm weather.

5. In 1896 Professor Morrill computed tables which have been used somewhat in the office, but never published, in which the mean temperature θ and the pressure arguments were restored, and the treatment of the humidity put on an improved

basis, though the plateau effect was omitted and the correction between t and θ only roughly determined.

The following statement will indicate the most important changes which have been recently adopted. The principles introduced by Ferrel have been more closely followed than any of the others, but decided improvements have become possible by reason of the gradual accumulation of accurate observations on the plateau. It was first necessary to construct exact normals of station pressure. There have been numerous changes in the location of the offices during the past thirty years, involving variations in the elevation; there has been a gradual improvement in the general national surveys for elevation by which the local bases can be referred to the sea level; the instrumental errors were neglected during certain years when less than, $\pm$ 0.007 inch; the observations have been made at different sets of selected hours; and the gravitation correction was not regularly applied. To reduce the entire set of observations from 1873 to 1900, inclusive, to a homogeneous system, they have been corrected to the elevation adopted for January 1, 1900, or the one occupied nearest that date, also to the mean of twenty-four hourly observations, and the corrections for instrumental errors and gravity have been added systematically. The monthly and annual means give the normals, and from these the variations in the year and from year to year are computed, the latter becoming the basis for the further discussion of climatic and seasonal problems.

The process of determining the sea-level temperature beneath the plateau was conducted as follows: The normal mean monthly temperatures of all stations between the Pacific coast and the Mississippi river were collected by groups according to their elevations, and reduced to selected planes through short distances. Thus all temperatures observed between 0 and 1,000 feet were corrected to the 500-foot plane, between 1,000 and 2,000 to the 1,500-foot plane and so on up to 7,000 feet. Temperature gradients in latitude and longitude were worked out by discussing these data, and then all the data on the selected planes were further corrected to values on the centers of reduction, that is the points where the five-degree meridians and the five-degree parallels intersect. The several stations were carried in various directions to different centers, so that purely local conditions might neutralize themselves. Over these centers we have thus formed from the observations different temperatures in a vertical direction, and they were then plotted as points on diagrams through the average of which vertical temperature curves were drawn, and prolonged to sea level without much error. These sea-level temperatures were now transferred to charts of the United States and Canada, and in connection with all the stations available from the Atlantic to the Pacific coasts, sea-level isotherms were readily drawn, by which all the minor discrepancies occurring in the plateau district were removed. By interpolation we then found the true terminals of the vertical temperatures at sea level on the centers of reduction. This entire work was performed two or three times in succession by a series of approximations, and the interlocking of the vertical and horizontal lines on the sea-level plane were made to conform to the observed conditions. Thence the sea-level temperatures for the respective stations were found by interpolation from the isotherms to tenths of a degree, so that we have thus accurately obtained t_0 as well as t.

The plateau effect was determined on the theory that the wide swing of the temperatures in the annual period, amounting to 0.400 inch, should be reduced to that which is observed at the low-level stations, about 0.150, by a correction of the form $C. \Delta\theta.H.$, where $C=0.00100$, $\Delta\theta$ is the departure of the temperature from the annual mean, and H is the elevation in units of a thousand feet. This is readily computed for each station, and it is to be added to the free air correction computed by the Laplacean formula with modern constants.

The monthly station pressures B were now reduced to sea level, giving B_0, and isobars were drawn as well as possible through the resulting values. Many of the old stations had their elevations determined only by barometers and were quite erroneous; in many cases the temperature argument used $\frac{1}{2}(t+t_0)$ was not exact enough to give very accurate results; not a few stations had only a short series of years to use in constructing their normals; from these causes considerable irregularities were found on the first system of sea-level maps. The pressures for each station were now interpolated from the map, B_m, and the differences, B_0-B_m, computed. For certain stations these differences were about constant, indicating an error in the adopted elevation, or in the mean temperature from which the plateau effect was reckoned; in other cases the differences had a variation in an annual period, showing that the true value of θ differs from $\frac{1}{2}(t+t_0)$. By readjusting our data to allow for all these considerations, the sea-level pressures were computed a second time. The differences, B_0-B_m, were now quite small for stations of long record, usually less than 0.010 inch. Assuming that the normal values of the short record stations should be reduced to the long record series, that is, 20 to 27 years, these last residuals were added to the original station pressures B to give the station homogeneous normals B_n. There still remain a few stations, some of them at low level, so that any adopted method of reduction cannot be a possible source of error, wherein a nearly constant residual reduction is yet required to reduce them to the homogeneous system, marked ΔA. This is probably due to some local peculiarity of the wind circulation, or the exposure of the barometer, and it may properly be considered as a topic for further investigation.

We next proceeded to make reductions for all the stations now in operation to the 3,500-foot plane and the 10,000-foot plane, both of which are useful in the studies of cyclones and anticyclones, but instead of directly from B to B_1 and B_2, by a roundabout circuit. The sea-level values $B_m . t_0 . e_0 .$ pressure, temperature, vapor tension, were interpolated on the centers of reduction from the sea-level charts. The temperatures $t_1 . t_2$ and the vapor tensions $e_1 . e_2$, on the two upper planes, respectively, were computed by gradients derived from the cloud computations of 1896–97, and balloon and kite ascensions. With this data charts of $t_1 . t_2 . e_1 . e_2 .$ were formed, the pressures $B_1 . B_2 .$ on these planes were computed by means of our new logarithmic general tables, and the corresponding pressure charts drawn. Thence the station data $B_1 . t_1 . e_1 .$ for the 3,500-foot plane and $B_2 . t_2 . e_2 .$ for the 10,000-foot plane were interpolated for each month and for the annual mean. As a check, station data $B_n . t . e.$ were reduced so as to give corresponding to B_n the values of B_1 and B_2. We have thus derived $B_1 . B_2$. by two separate methods, and they generally agree to about 0.01 inch on the average. This check includes the construction of the general tables and the special station tables, also the drawing of the different sets of charts. We have therefore obtained the same results by means of two paths of reduction, the first to sea level from the station, and thence through the centers of reduction to the two higher planes, and thence by interpolation to points over the station; the second, from the station pressure to the pressures on the two other planes directly. This agreement, therefore, unites the entire data in a homogeneous system, and it becomes the basis for future substantial scientific discussions in many meteorological problems. We can now deal quite confidently with hundredths of an inch of pressure.

A full report on this subject will appear in the Annual Report, Chief of Weather Bureau, Vol. II., 1900–1901, and will contain the following sets of charts for each month and for the year, $B_m \cdot t_0 \cdot e_0 \cdot$ and the relative humidity on the sea level plane, $B_1 \cdot t_1 \cdot e_1$ on the 3,500-foot plane, $B_2 \cdot t_2 \cdot e_2$ on the 10,000-foot plane, 130 in all; also charts of gradients in latitude, in longitude and in altitude, as well as charts for reducing selected hours of observation to the mean of twenty-four hourly observations. With these data a newly opened station can by a little computation be put on a better basis regarding its normals than would be given by at least ten years of regular observations. A summary table contains the above list of normals for 265 stations besides the original data for the station $B_n \cdot t \cdot e.$, and will be a valuable source of reference for numerous questions in meteorology.

The reduction tables for pressure consist of three different sets: (1) The general logarithmic tables computed for every 100 feet up to 10,000 and for every 10 degrees from $-40°$ to $+100°$; (2) the station tables for publication, containing the following corrections for each of our three planes of reference, sea-level, 3,500-foot and 10,000-foot, namely, the Laplacean free dry air correction, the humidity correction, the correction for the plateau effect and the occasional residual correction, also the two arguments t surface temperature and θ the mean column temperature. Diagrams have been constructed to show the relations between t and θ, and they form a most instructive analysis of the plateau temperature problem, showing that each district has local characteristics of its own; (3) the station tables are compiled from the forms (2), and they are expanded for the arguments surface t and surface B, so that there shall be no interpolation along the temperature argument in order to obtain the nearest hundredth of an inch, 0.010. The body of the table gives the reduced pressure on its plane, and not the correction to the actual pressure, which must be added to it to produce the reduced pressure, as is customary in such tables. There remains only a very simple interpolation for the intervals of a tenth of an inch of pressure to the required hundredth of an inch. It is thus an easy matter to enter the three tables in succession with the same arguments, surface $(B \cdot t)$, and find $B_0 \cdot B_1 \cdot B_2$. These data will enable us to construct three sets of isobars at each hour of observation, showing three plane sections through the atmosphere, and these will probably prove to be of value in the forecasts of the weather conditions. The sea-level reductions went into operation on January 1, 1902, as stated, but some more work is required to furnish the stations the necessary tables of group (3), the two preceding groups being completed.

FRANK H. BIGELOW.

WEATHER BUREAU.

SCIENTIFIC BOOKS.

Memorial Lectures delivered before the Chemical Society of London, 1893–1900. London, Gurney and Jackson, Paternoster Row. 1901. 8vo.

This volume contains the lectures commemorating deceased honorary and foreign members of the Chemical Society of London, delivered during the eight years designated in