placing or absorbing it, is it not likely that such an event has occurred frequently and in many different parts of the earth's crust? Geological records are, indeed, full of suggestions that such is the case. Yet in all our current discussions of orogeny, epeirogeny, and regional metamorphism, how little is this factor in the problem considered? What part has the development of the Nova Scotia batholite played in the folding of the Cambrian strata of that province, in their metamorphism and in their becoming charged with gold? What part has the development of the great batholite of the Sierra Nevada played in the folding and metamorphism of the earlier Mesozoic rocks of California and in their becoming charged with gold? What part has the development of the great British Columbian batholite played in the folding and metamorphism of the earlier Mesozoic strata of the west coast of that province? Was the British Columbian batholite synchronous in its development with the Sierra Nevada batholite? Are they separate and distinct affairs, or are they simply geographically separate manifestations of one stupendous process of crust development? In either case has not the exposure by denudation of these great batholites and their intrusive relations to the surrounding terranes practically reproduced the conditions which we find in the Archæan terranes of the Canadian plateau? These are a few of the questions which can only be profitably discussed when the batholite is recognized as a much larger element in tectonic geology than the dyke, the neck, the boss, the sill, or the laccolite. Batholites abound. Why should they not be recognized?

2. A second important result is the immense simplification which is effected in Archæan geology in the Canadian territory, where most questions of that ilk must find their final solution. Hitherto the Norian rocks have been classed as part of a supposed system of metamorphic sedimentary strata known as the Laurentian. This system was divided by Logan into an upper and a lower division, the latter being sub-divided into two parts, viz.: the Grenville series and the Ottawa gneiss, so that his scheme stood thus:—

Norian series = Upper Laurentian
Grenville series = Upper division } of Lower Laurention.
Ottawa gneiss = Lower division }

The recognition of the irruptive character and post-Grenville age of the Norian rocks is a great gain, and reduces the Laurentian system to two members. The simplification thus effected suggests to the present writer still other possibilities in the same direction. It seems probable that the Grenville is a profoundly metamorphosed series of sedimentary strata. Its bedded character and the fact of its being composed of strata of limestone, quartzite, iron ore, graphite, etc., in addition to the gneisses, favor this view. The Ottawa gneiss, on the other hand, has a very different character. There are no beds of limestone, or quartzite, or iron ore, or graphite. The mass of the formation is eminently granite, with gneissic foliation, which in some cases is well defined, and in others vague or almost absent. What is the relation of the Ottawa gneiss to the Grenville series? The former would be recognized by any petrographer as a granite — a plutonic igneous rock. Professor Adams recognizes the geological identity of the Ottawa gneiss with the Laurentian gneiss and granite which the writer has described as invading the upper division of the Archæan complex (Ontarian system) in the region northwest of Lake Superior. There the igneous irruptive and batholitic character of the granites and gneisses (= Ottawa gneiss) and its invasion of the Upper Archæan rocks is unequivocally demonstrated by evidence which has been abundantly adduced elsewhere. Does the Ottawa gneiss of the Ottawa valley bear a similar batholitic and intrusive relation to the Grenville series? From what the writer knows of the region, it seems to him eminently probable that such will be found to be the case. This hypothesis is favored somewhat by certain harmonious analogies which it would establish between the Archæan complex in the Lake Superior region and the region of the Lower Ottawa. Generally, the Archæan complex throughout Canada, omitting the Norian, is composed of two great divisions. The lower division seems generally to have the petrographical characters of the Ottawa gneiss. The upper division is usually recognizable as an assemblage of metamorphic, sedimentary, or mixed sedimentary and volcanic strata. Part of this upper division has usually been referred to as Huronian, but, according to several authorities, this term was originally applied to a post-Archæan series on the north shore of Lake Huron; and there is some confusion attending its use. Even when applied to Archæan rocks, the term has embraced only a portion of the upper division of the complex. In western Ontario, this upper division includes at least one other group besides that which has usually been called Huronian. The writer has elsewhere proposed the term "Ontarian system," as a comprehensive designation to embrace the whole of the upper division of the Archæan in western Ontario. Now it seems to the writer that the Grenville series in Quebec occupies the same stratigraphical position in the Archæan complex as does the Ontarian system (embracing Contchiching and Keewatin [Huronian?]) in western Ontario. Admitting, for the sake of clearly stating the hypothesis, that the Grenville series is the equivalent of Ontarian system, or any part of it, we would have the following parallelism:—

	Western Ontario and Minnesota.	*Eastern Ontario.*	*Quebec.*
In order of superposition.	Ontarian system	Hastings series	Grenville series
	Laurentian system	Ottawa gneiss	Ottawa gneiss
	[1] Carltonian { Anorthosites of Minnesota		Norian
In order of chronological sequence; an irruptive rock being of later age than the formations which it invades.	[1] Carltonian { Anorthosites of Minnesota		Norian
	Laurentian System { Batholitic Granites and Gneisses	Ottawa gneiss	Ottawa gneiss
	Ontarian System	Hastings series	Grenville series

[1] See Bulletin, No. 8, Geolog. and Nat. Hist. Surv. of Minnesota.

If this hypothetical correlation should ever be established, it would then seem that different names and different stratigraphical positions had been given to groups of strata geologically equivalent because of their petrographical dissimilarity. The Grenville series is characterized by limestones and quartzites, with little or no volcanic admixture. In the Ontarian system of western Ontario sedimentary rocks, in a more or less metamorphic state, are common enough; but there is a scarcity of crystalline limestones and quartzites, and altered forms of volcanic rocks abound. This petrographical dissimilarity, however, in no way militates against their geological correlation. It is interesting to note in this connection that the Hastings series, which is geographically between the Quebec region and the Lake Superior region, is intermediate in petrographical character between its suggested equivalents on either side. By some authors it has been correlated with the Grenville series, and by others with the Huronian (Archæan).

GEOLOGY OF TUCUMCARI, NEW MEXICO.

BY W. F. CUMMINS, TEXAS GEOLOGICAL SURVEY, AUSTIN, TEXAS.

IN 1852, Professor Jules Marcou, as United States geologist, made a trip across the country with the engineers who were sent out to survey a railroad route from Fort Smith, Ark., to the Pacific Ocean, near the thirty-second parallel. On that trip he passed through the Tucumcari region, and published a description and section of Pyramid Mountain, one of the representativ

buttes. From the strata at Pyramid Mountain and other places in the vicinity he collected a number of invertebrate fossils, two of which he figured and described as *Ostrea marshii* and *Gryphœa dilatata*, var. Tucumcari, Marcou, and referred them to the same species as those described in Europe under the same names.

The collections of Professor Marcou were placed, by order of the Secretary of War, in the hands of W. P. Blake for description. He differed entirely with Professor Marcou in his identification of the fossils, and referred them to *Ostrea subovata*, Shumard, and *Gryphœa pitcheri*, Morton. Others engaged in the controversy, which became very personal and bitter, and the wounds made by the lances of the combatants have not healed to this day.

The locality was not visited again by any geologist until, in 1888, Mr. R. T. Hill visited the place and made a short stay. He visited it again in 1891 and made further observations. In 1891 I visited the locality, made many sections of the hills in the vicinity, and collected a large number of fossils. This comprises all the geological work in that immediate vicinity, so far as I am informed.

Professor Marcou referred the strata to the Triassic and Jurassic, basing his conclusions as to the Jurassic upon the fossils found there, which he claimed were identical with those found only in the Jurassic of Europe. There is now no dispute about the correctness of his reference of the lower beds to the Triassic.

After Mr. R. T. Hill's first visit he published a paper, in which he said he was inclined to confirm Marcou's reference of the upper beds to the Jurassic. After his second visit he again confirmed Marcou's reference; but upon further consideration he concluded that the beds belonged to the Cretaceous.

When I visited the place I took time to collect fossils and study the stratigraphy and lithological character of the several parts of the formation, and the result was that I could not agree with either of my predecessors. I found evidence there of the existence of the Triassic, Cretaceous, and Tertiary. Since the publication of Mr. Hill's latest paper there is no disagreement between us. Professor Marcou still contends for the correctness of his reference of the upper beds to the Jurassic.

The evidence of the Cretaceous age of the middle part of the strata is based upon the fossils I found in the beds, associated with those from the same place found by Marcou. The following is a list of the fossils found by me:—

Gryphœa dilatata, var. Tucumcari Marcou; *Ostrea marshii*, as determined by Marcou, but in reality *Ostrea subovata*, Shumard; *Gryphœa pitcheri*, Morton; *Exogyra texana*, Roemer; *Ostrea quadriplicata*, Shumard; *Trigonia emoryi*, Con.; *Cardium hillanium*, Sow.; *Cytheria leonensis*, Con.; and a single leaf of a dycotyledonous plant, which I described and figured under the name *Sterculia Drakei*.

It will be apparent to everyone acquainted with the fossils of the Cretaceous that those enumerated belong only to Cretaceous strata, and, if taken from the beds of the Tucumcari region and correctly determined, the conclusion that the beds are Cretaceous would be inevitable.

Professor Marcou, therefore, seeing this, in reviewing my publication, endeavors to avoid the conclusion by saying that either the determinations of the fossils found by me were incorrect or that they did not come from that locality, and suggests that the labels on my packages were loosely put on and became mixed with collections made elsewhere; and on this flimsy subterfuge (to give it no harder name) still insists on the correctness of his reference to the Jurassic.

A simple recital of the circumstances attending the collection, shipment, and determination of the fossils under consideration will be sufficient to satisfy any reasonable mind on both doubted points, especially in the absence of any motive for deception on my part. The facts are that for more than a month prior to the collection of the fossils in dispute we had not collected a single one from any Cretaceous bed, and every package previously collected had been shipped to the museum. Those collected at Tucumcari were shipped overland to Las Vegas, New Mexico, were delayed there for several months, and did not arrive at Austin until every package collected from other localities had been opened and put in the cases. When the boxes containing the Tucumcari collections arrived, instead of opening them as the other collections were in the storage room, I had them taken to my private room, opened them myself, and put them in a separate case, where they are now with the labels originally placed on them in the field. There were at least fifty packages of these fossils, and each package had two labels attached, so that it is utterly impossible for them to have become mixed by accident or carelessness.

Again, myself and my assistants discussed the fossils in the field as we picked them up, and our note-books show that we then determined them as they are now designated. There can therefore be no reason for supposing that the fossils did not come from that locality, notwithstanding Professor Marcou says that he did not find such fossils there, as if that fact could justify him in saying another explorer did not. Marcou travelled rapidly through the country, made a section at one place, and devoted six hours to the examination of the strata at that precise locality, while I travelled at my leisure, and took all the time necessary to collect the fossils.

He says he has seen the collection of Professor A. Hyatt made in that vicinity, and that there are none of the fossils enumerated by me in his collection. Professor Hyatt has never said that he collected fossils from that locality, and so far as I know he never did; but even if he had, would that be a reason for concluding that another person could not find other fossils? Professor Hyatt has written no paper on that region.

As to the correctness of the determination of the fossils, I took every precaution to prevent any mistake in this matter. I did not wholly rely upon my own judgment, but, after opening up my collection, I made up small suits and sent them to various parties for determination, without giving them the location from which they were collected, but simply asking for specific determinations, and without repeating what others had said, or even giving my own conclusions, and there was unanimous agreement as to all the species I have published.

It will thus be seen that I have taken extraordinary care to be certain of my facts before publishing them and my conclusions drawn therefrom.

The evidence of the Jurassic age of the beds relied upon by Professor Marcou is based upon two species found in the beds, described by him as heretofore mentioned. One of them he calls *Gryphœa dilatata*, var. Tucumcari Marcou, and the other *Ostrea marshii*.

After making my collection at Tucumcari, I sent to Europe for samples of the *Gryphœa dilatata* from the type localities and compared them with Marcou's variety collected by me. The best that can be said is that it may be a variety of the original type.

The samples collected by me of what I suppose was his *Ostrea marshii* are not *O. marshii*, but *O. subovata* of Shumard. We have hundreds of specimens of *O. subovata* in the museum, collected from well-known Cretaceous horizons, and upon comparison with them the specimens from Tucumcari are found to agree in every essential particular. Therefore the proof of the Jurassic age of the beds is narrowed down to one fossil, and that only a variety of the form found in the Jurassic of Europe, and which has not been reported from any of the well-known Jurassic horizons in North America. This will certainly not be considered sufficient to establish the Jurassic age of the beds when there is associated with it the other forms enumerated which are certainly Cretaceous.

I placed a great deal of stress upon the fact of having found in these beds a dicotyledonous leaf, as proving the Cretaceous age of the beds, for the reason that, so far as I know, no dicotyledons have been reported from any strata lower than the Cretaceous, in either North America or Europe. It is true that they have been reported from beds which some geologists held to be Jurassic, but which by others were referred to the Cretaceous upon the very ground that they contained dicotyledons.

Professor A. Hyatt has been quoted as expressing the opinion in private that the beds at Tucumcari were Jurassic, but in a recent article he deprecates such a use of his opinions privately expressed, says it was unauthorized, and asserts that he has no opinion on the subject.