STRATIGRAPHIC SUCCESSION IN THE REGION NORTH-EAST OF COOK INLET, ALASKA*

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(Presented by title before the Society December 29, 1906)

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INTRODUCTION

The facts to be presented here were gathered during the summer of 1906, while undertaking a rapid geologic reconnaissance in the region northeast of Cook inlet, Alaska.

REGION INVESTIGATED

Cook inlet occupies a broad indentation on the western side of the gulf of Alaska. The region explored is drained by two rivers—the first, the Matanuska, emptying into Knik arm at the head of Cook inlet; the second, Sushitna river, emptying into Cook inlet proper. Though portions of the region have been visited at various times in the past by Eldridge,‡ Mendenhall,§ and Martin,|| much of the area is unknown. A notable

* Received by the Secretary of the Society May 28, 1907.

† Introduced by Alfred H. Brooks.

‡ G. H. Eldridge: Reconnaissance in Sushitna basin, Alaska, 1898. Twentieth Ann. Rept. U. S. Geol. Survey, pt. vii.

§ W. C. Mendenhall: Reconnaissance from Resurrection bay to the Tanana, Alaska, 1898. Twentieth Ann. Rept. U. S. Geol. Survey, pt. vii.

|| G. C. Martin: Reconnaissance of the Matanuska coal field, Alaska. Bull. no. 289, U. S. Geol. Survey.

development of Jurassic and Tertiary sediments and the presence of workable commercial coal in such a remote district seem of sufficient importance to warrant the presentation of the following facts:

SCOPE OF THE PAPER

An attempt will be made to give a brief statement of the stratigraphic succession in the area traversed. It should be stated that diverse parts of the field were covered by the writers respectively, and that the observations thus made were therefore in part supplemental. While the fauna of Mesozoic age was almost in its entirety collected in the region east of Chickaloon creek, the flora of the Kenai (Upper Eocene) was found on the lower Matanuska river and on Chickaloon creek.

DISTRIBUTION OF THE TERRANES

A glance at the map will show in a broad way the distribution of the several terranes. It may be seen that the boundary between the Tertiary and Mesozoic sediments trends northwest across Matanuska valley about 70 miles from tide water. The area mapped as granite was only studied along the margin, and other rocks may be included within it. Bordering this central granite mass on the western and northwestern margins is a series of slates and graywacke-slates; on the southern flank it is in part bounded by a narrow belt of mica-schist.

The oldest rocks of the region are probably represented by a series of crystalline schists comprising garnetiferous mica-schist and chloritic albite-zoisite schist. On the basis of petrographical similarity, they are correlated with the schists of the Yukon-Tanana region and tentatively assigned to a pre-Silurian age.

The next youngest rocks are a slate and graywacke-slate series, closely folded and of unknown thickness. No fossils have been found in them, so that their age is purely conjectural. They show, however, some resemblance to the rocks of the Sunrise series, which are regarded as of Upper Paleozoic age.

MIDDLE JURASSIC

The lowest rocks of determined age are Jurassic beds developed in the region of the upper Matanuska river and in the valley of Chickaloon creek and Talkeetna river. They have also been found as far north as the headwaters of Sushitna river.

These strata of Middle Jurassic age are divided into two series, separated by a pronounced unconformity. The lower series will be described first.

FIGURE 1.—Geologic Map of Region Northeast of Cook Inlet, Alaska.

Greenstones and related pyroclastics constitute the most characteristic portion of these rocks. Tuffs, agglomerates, and flow breccias form the great bulk of the greenstones, and intercalated flows of coarse amygdaloid are of frequent occurrence. Examination in thin-section shows that the greenstones and their ejectamenta are andesites of hyalopilitic and pilotaxitic textures, more or less thoroughly chloritized.

The thickness of this accumulation often exceeds 1,000 feet. The tuffs locally carry fragments of lignite, and at one point were found to contain marine shells in a fine state of preservation. The fossils were submitted to Dr T. W. Stanton, who reports in part:

<i>Rhynchonella.</i>	<i>Astarte</i> (?).
<i>Lama.</i>	<i>Protocardia.</i>
<i>Pecten</i> —smooth species.	<i>Pleuromya.</i>
<i>Pecten</i> —species of <i>Vola</i> type.	<i>Somminia</i> (?).
<i>Trigonia.</i>	

"The Jurassic age of this lot is clearly shown by the form of the *Trigonia* and of the *Ammonite* (*Somminia* ?). The general aspect of the fauna is that of the lower part of the Enochkin (Middle Jurassic)."

The greenstones and tuffs just described are transitional into an overlying series of graywackes, sandstones, shales, and subordinate conglomerates.

Several of these latter, of very diverse constitution, occur interstratified with seams of low-grade bituminous coal. In the northeastern part of the field several hundred feet of stream bluffs 100 feet high are composed of conglomerate consisting of various porphyries and white quartz pebbles in a gritty, coherent matrix.

The shales and sandstones of this series are in general barren of fossils, though *Belemnites* are rather common.

<i>Inoceramus</i> cf. <i>lucifer</i> Eichwald.	<i>Stephanoceras.</i>
<i>Pleuromya.</i>	<i>Oppelia</i> (?).
<i>Pleurotomaria.</i>	<i>Natica.</i>
<i>Phylloceras.</i>	<i>Somminia</i> (?)—two species.

Doctor Stanton, who examined the fossils, states "that they may be referred without question to the lower part of the Enochkin formation as it occurs at Snug harbor," on the west coast of Cook inlet.

The beds are usually lying in monoclinal attitudes, broken by block faulting. Whatever folding is shown is, with one exception, of an open character. Evidence, however, of severe internal disturbance, such as the frequency of faulted pebbles in the conglomerates, is abundant, and shattering and minor faulting are widespread.

The series of rocks just described are separated from those next higher in the column by an important unconformity. At one point sandstones introduced by a thin basal conglomerate were found resting on the eroded edges of the Lower Middle Jurassic greenstones. The absence from the younger rocks of the profound shattering and shearing characteristic of the older rocks, and the strong discordance in their respective strike lines,

amounting to nearly 90 degrees, is strong evidence of this unconformity in portions of the field where direct contacts are not observable.

The overlying younger series forms a continuous stratigraphic succession of younger Middle Jurassic and of Upper Jurassic rocks. They consist largely of soft blue shales locally carrying fossiliferous limestone nodules. With the shales are associated various sandstones, often of loose coherent texture and containing great multitudes of *Aucella*. Interstratified beds of andesitic tuff, containing *Belemnite* remains, and hornblende-biotite arkose are also found. In the eastern part of the field stream bluffs reveal a curious interdigitation of lenses of cross-bedded sandstone carrying *Aucella*, of shale beds, and of coarse conglomerate lenses. Solitary water-worn boulders are found embedded in the shale lenses. These various characteristics are held to belong to an ancient delta deposit. In harmony with this interpretation is the fact that the *Aucella* characteristic of these rocks is often found in soft sandstones interstratified with sandstones inclosing abundant carbonaceous fragments.

At the head of Matanuska river the upper horizons of the shale become strongly calcareous and there show pronounced ripple-marking.

The fauna of the above succession of rocks is as follows:

Cadoceras sp.

Aucella cf. *bronni* Rouiller.

Pleuromya.

The fossils indicate faunas of both the upper part of the Middle Jurassic and of the Upper Jurassic. The former is the *Cadoceras* zone of the west shore of Cook inlet, while the latter is the *Aucella bronni* zone of the same region.

It is interesting to note that the Upper Jurassic rocks of the Matanuska region, which are faunally allied to those of the Naknek formation on the west coast of Cook inlet, show a certain lithologic similarity in the presence of interstratified tuffs and arkose.*

On the headwaters of Sushitna river is a notable accumulation of conglomerate. Perpendicular cirque walls cut in it reveal a thickness of not less than 1,100 feet. Sandstone layers show it to be lying in horizontal attitude. The conglomerate, especially in its upper horizons, consists exclusively of large, well-rounded boulders of augite-andesite and very fresh hornblende-biotite-quartz monzonite imbedded in a tuffaceous matrix. Sheets of lava are intercalated in the conglomerate. The stratigraphic relations of this deposit were not seen, but on lithologic reasons it is corre-

* T. W. Stanton and G. C. Martin: Mesozoic section on Cook inlet and Alaska peninsula. Bull. Geol. Soc. Am., vol. 16, pp. 391-410.

lated with the Naknek (Upper Jurassic of Cook inlet), at the base of which a very similar accumulation occurs.

LOWER CRETACEOUS

Rocks of Lower Cretaceous age are represented mainly by but a single formation—a massively bedded limestone, 300 feet thick, which overlies the Upper Jurassic rocks conformably. The limestone is very finely saccharoidal in texture and white in color. A characteristic feature is its strong, fetid odor on fresh fracture. The age determination of this limestone is based on the presence of *Aucella crassicollis* Keyserling, obtained by Mendenhall. It may thus be seen that the rocks from the upper part of the Middle Jurassic through the Lower Cretaceous are in conformable succession.

TERTIARY

The next youngest rocks of the region are of Upper Eocene (Kenai) age. They are a series of shales, sandstones, and conglomerates containing workable seams of high-grade bituminous coal of a maximum thickness of 17 feet.* A section exposed in Castle mountain shows 1,000 + feet of conglomerate at the base, overlain by sandstones and shales. At least 3,000 feet of these sediments were observed in a locality on Chickaloon creek.

The nature of the relations of these rocks to the Mesozoic series is yet in doubt. There are reasons, however, for believing that they overlie them unconformably.

No marine fossils have been found in this series, but floral remains, rather poorly preserved, are at times quite abundant. Dr F. H. Knowlton reports the following forms:

<i>Sequoia langsdorffii</i> (Brgt.) Heer.	<i>Taxodium distichum miocenum</i> Heer.
<i>Ficus ? grönlandica</i> Heer.	<i>Taxodium tinajorum</i> Heer.
<i>Magnolia ingletfeldi</i> Heer.	<i>Paliurus colombi</i> Heer.
<i>Populus arctica</i> (?) Heer.	Fruits, cf. <i>Leguminosites</i> sp.
<i>Rhamnus eridani</i> Heer.	Age, Kenai (Upper Eocene).
<i>Viburnum</i> sp., cf. <i>V. nordenskiöldi</i> Heer.	

Overlying the older rocks is a series of nearly horizontal lava flows, basaltic in character. With their tufts and breccias they attain a thickness of 1,000 feet. They are definitely known to overlie fluviatile conglomerates of post-Lower Cretaceous age, and probably rest on the Kenai so that their age is Middle Tertiary or younger.

* G. C. Martin: A reconnaissance of the Matanuska coal field, Alaska. Bull. no. 289. U. S. Geol. Survey.

The most recent deposits of the area are Pleistocene stream and glacial gravels. This formation is most extensively displayed near the head of Matanuska river, where the present stream gorge has cut through 300 or 400 feet of glacial gravels.

INTRUSIVE IGNEOUS ROCKS

In addition to the stratiform volcanics of Middle Jurassic and Tertiary ages, igneous rocks of intrusive character are abundant in certain parts of the region. Of these diabase dikes and sills are widely prevalent, attaining a maximum thickness of 500 feet. They are intrusive into rocks as late in age as the Kenai.

The granular plutonics making up the central mass of the Talkeetna mountains, however, possess far wider interest on account of their connection with problems of great geological significance. They are chiefly quartz-diorites carrying orthoclase, and are intrusive into rocks at least of Lower Middle Jurassic age. They are thus contemporaneous with the enormous batholithic intrusions of the late Mesozoic, which affected the entire Cordilleran region from the strait of Magellan to the Seward peninsula, in northwestern Alaska.*

SUMMARY

The rocks of the area investigated range in character from garnetiferous mica-schists of pre-Silurian age to unconsolidated Pleistocene stream and glacial gravels. The region, however, is chiefly noteworthy on account of the extensive development of marine Jurassic strata and the presence of Upper Eocene fresh-water sediments carrying thick seams of bituminous coal.

The stratigraphic column may be summarized as follows:

	Feet
Pleistocene.—Stream and glacial gravels.	
Unconformity.	
Post-Eocene.—Basaltic lavas and pyroclastics.....	1,000 +
Upper Eocene.—Kenai formation: Sandstones, shales, and conglomerates, with coal seams.....	3,000 ±
Unconformity (?)	
Lower Cretaceous.—Limestone	300
Conformity.	

* A. C. Lawson: The Cordilleran Mesozoic revolution. *Journal of Geology*, vol. 1, p. 579.

A. H. Brooks: The geography and geology of Alaska, P. P. 45, p. 250, U. S. Geol. Survey.

	Feet
Upper Jurassic to Upper Middle Jurassic.—Sandstones, shales, conglomerates, tuffs, and arkose.....	2,000 ±
Unconformity.	
Lower Middle Jurassic.—Meta-andesites and pyroclastics, graywackes, sandstones, shales, and conglomerates.....	2,000 ±
Unconformity (?)	
Upper Paleozoic (?)—Slates and graywacke-slates.	
Unconformity (?)	
Pre-Silurian (?)—Garnetiferous mica-schists and chloritic albite-zoisite schists.	
Intrusive quartz-diorites.—Intrusive into Lower Middle Jurassic rocks.	