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STUDY OF HEAVY MINERALS FROM TERTIARY ROCKS AT CAPPS GLACIER AND ADJACENT AREAS, SOUTHERN ALASKA

By

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INTRODUCTION

This report describes an investigation of the feasibility of using heavy-mineral analyses to aid identification and correlation of major stratigraphic units of Tertiary age in the Cook Inlet basin, southern Alaska. The work is based on heavy-mineral extractions from rock samples collected during detailed examination of selected exposures of Tertiary rocks along the south side of Capps Glacier and at two places along the Chuitna River (Adkison and others, 1975), approximately 60 miles west of Anchorage (fig. 1). The stratigraphic distribution of the samples is given in plate 1. The heavy-mineral suites from these rocks are correlated with heavy-mineral suites from selected cores from the Deep Creek Unit well, Kenai Peninsula, Alaska (fig. 1).

Tertiary rocks discussed in this report were first assigned to the Kenai Formation by Eldridge (1900, p. 21) who reported coal-bearing Tertiary rocks in the sea cliffs west of Tyonek and inferred their presence in the Beluga River and Chuitna River areas. Spurr (1900, p. 172, 184) considered the coal-bearing strata along the northwest side of Cook Inlet older than the Kenai Formation exposed along the west side of the Kenai Peninsula. The most comprehensive study of Tertiary rocks northwest and north of the Cook Inlet was done by Barnes (1966) who referred to the rocks in the Capps Glacier area as the lower

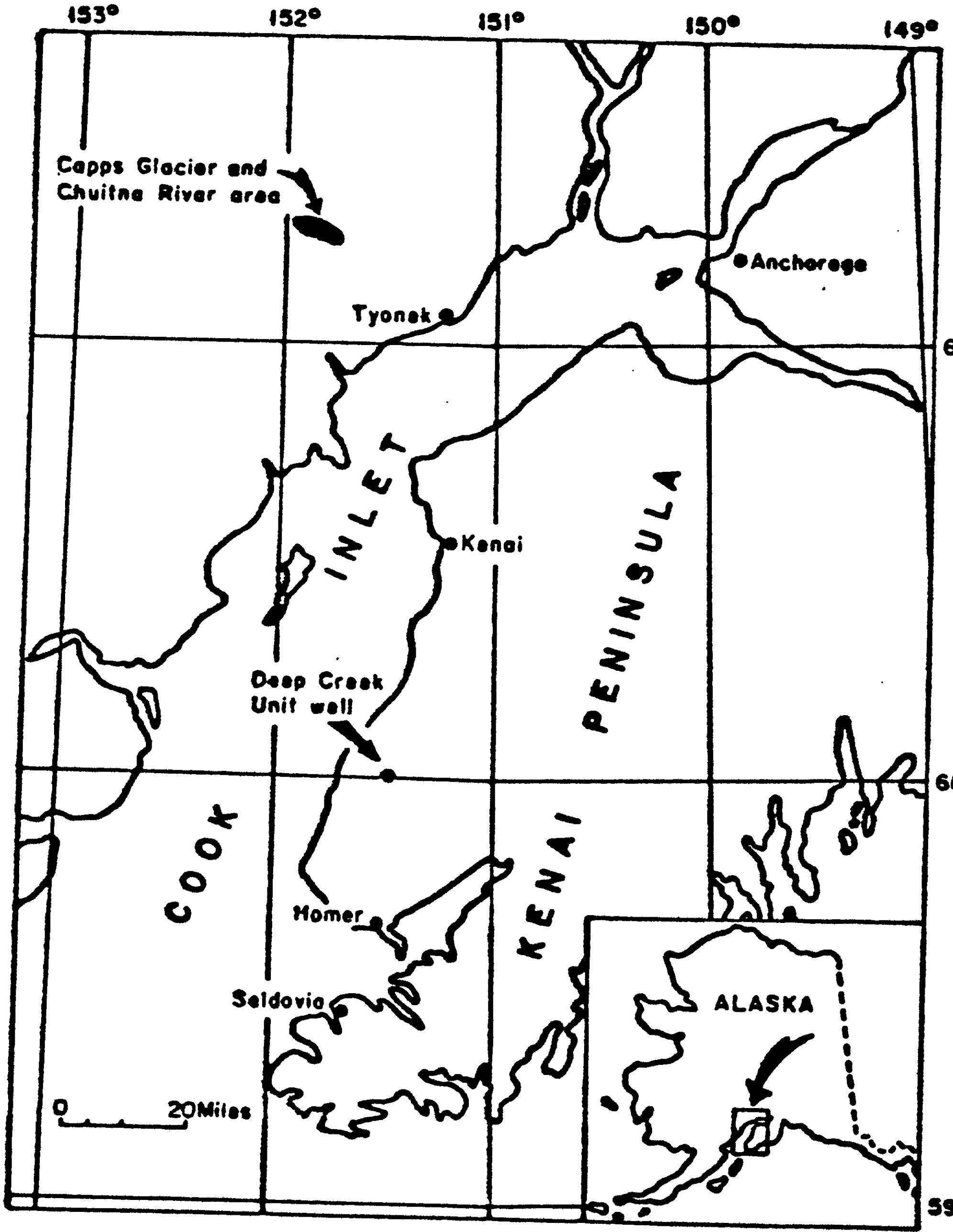

Figure 1. Location of Deep Creek Unit well and Capps Glacier and Chuitna River area

conglomerate member of the Kenai Formation. He assigned the strata exposed near the toe of Capps Glacier and along the Chuitna River to the coal-bearing middle member of the formation. Wolfe, Hopkins, and Leopold (1966) proposed three provincial time-stratigraphic units based on leaf fossils for the Tertiary rocks in the Cook Inlet basin; these are, in upward order, the Seldovian, Homerian, and Clamgulchian Stages. Tertiary rocks near the toe of Capps Glacier were designated part of the type section of the Seldovian Stage (Wolfe and others, 1966, pl. 1). Calderwood and Fackler (1972) proposed that the Kenai Formation be raised to Kenai Group, and they named five new formations within the group. These formations, in upward order, are the West Foreland Formation, Hemlock Conglomerate, Tyonek Formation, Beluga Formation and Sterling Formation. Magoon, Adkison, and Egbert (1976) proposed that the Kenai Group be restricted to the Hemlock Conglomerate, Tyonek Formation, Beluga Formation, and the scattered unidentified exposures of Tertiary rocks on the west side of the Cook Inlet basin were assigned to the West Foreland Formation by Calderwood and Fackler (1972, p. 742, 744, 745). They regard exposures along Capps Glacier as possibly equivalent to the Hemlock Conglomerate, and those along the upper Chuitna River as equivalent to the Tyonek Formation. Kirschner and Lyon (1973, p. 402, 403, fig. 11) consider the rocks exposed in the area of this report to be equivalent to the West Foreland Formation in the Capps Glacier area and the Hemlock Conglomerate and Tyonek Formation, undifferentiated along the Chuitna River.

The rocks sampled in this study were assigned by Adkison, Kelley, and Newman (1975) to the West Foreland and Tyonek Formations; the Hemlock Conglomerate was interpreted to be absent by erosion or nondeposition. Their assignment of these rocks was based on comparison of the palynomorphic successions in the Capps Glacier and Chuitna River areas and the Deep Creek Unit well where a reference section was established (Adkison and Newman, 1973). On the basis of new leaf-fossil data, the contact between the West Foreland and Tyonek Formations at Capps Glacier was revised upward so that the West Foreland includes all of the conglomerate and sandstone sequences (Magoon and others, 1976, p. 12).

The work for this report was done under cooperative agreement between the U.S. Geological Survey and the Division of Geophysical and Geological Surveys, Department of Natural Resources, State of Alaska. The writer appreciates the assistance of D. C. Hartman, former State Geologist, and T. R. Marshall, Jr., Chief Petroleum Geologist, Division of Oil and Gas.

Procedure

Samples of sandstone and siltstone were taken from selected outcrop samples representing each major rock type exposed in the Capps Glacier and Chuitna River areas. They were mechanically disaggregated and, if necessary, treated with cold 5-normal hydrochloric acid. The disaggregated samples were washed with water to remove as much clay-size material as possible. They were then dried and sieved. The portion of each sample greater than 0.124 mm but less than 0.61 mm was saved and washed with water again to remove any remaining clay-size material. These samples were then dried and placed in separatory flasks equipped with stopcocks. Bromoform with a specific gravity of 2.85 was used for the initial separation. The resulting heavy-mineral fractions were further treated with a mixture of bromoform and methylene iodide having a specific gravity of 3.00. Magnetite and tramp iron was removed by hand magnet. The heavy-mineral separates were then split if the volume permitted. Splits were subjected to x-ray diffraction analysis. A portion of each heavy-mineral separate was cemented to a glass slide with Lakeside 70 and examined quantitatively using a petrographic microscope equipped with a mechanical stage. Between 100 and 200 nonopaque monomineralic grains were identified on each slide. These data were reduced to percent abundance of each mineral species. The results were tabulated stratigraphically (table 1).

Results

The heavy-mineral residues from the Tertiary rocks along Capps Glacier and the Chuitna River include nine principal constituent minerals and twelve minerals present in minor amounts. Principal constituent minerals are those minerals that occur in most samples or occur in large quantities in a few samples. These minerals are aegirine-augite, apatite, epidote, garnet, brown hornblende, green hornblende, sphene, tourmaline, and zircon. Minerals catagorized as present in minor amounts occur in amounts less than 10 percent and are often questionably identified.

Some minerals are probably more useful than others for stratigraphic subdivision of these rocks. Useful minerals are restricted in either their presence or abundance to particular stratigraphic intervals. The most useful of these minerals are those which occur in amounts great enough to assure their accurate detection and to permit comparison of relative abundances between individual samples. These minerals are aegirine-augite, garnet, brown hornblende, sphene, tourmaline, and zircon. Apatite and epidote are present in significant amounts, but their near-ubiquitous distribution makes them of little value in either stratigraphic differentiation or correlation. Minerals present in minor amounts do not appear to be valuable in stratigraphic differentiation, except for clinozoisite.

Three poorly defined subdivisions are recognized within the Tertiary section at Capps Glacier and along the Chuitna River. The stratigraphically lowest unit includes sample numbers 13-3, 13-12, 13-16, 13-18, and 13-24 (table 1). The middle unit includes sample numbers 14-8, 14-38, and 14-67/68. Sample numbers 15-3, 15-30, 15A-5, 15-34, 15-40, 15-49, 16-4, 16-9, 16-19, 17-1, 17-8, and 17-15 represent the upper unit.

The stratigraphically lowest unit is characterized by an abundance of green hornblende, lack of sphene and aegirine-augite, near-trace amounts of garnet, and small amounts of brown hornblende. The presence of significant amounts of green hornblende in every sample in this unit distinguished it from the upper unit which contains significant amounts of green hornblende in only two samples. The lack of sphene, little garnet, and little tourmaline further distinguish the lower unit from the upper unit.

Aegirine-augite marks the heavy-mineral suite of the middle unit in contrast to those of the upper and lower units. Near-trace amounts

TABLE I. ANALYSES OF HEAVY MINERAL SAMPLES

SAMPLE NO.	13-3	13-12	13-16	13-18	13-24	14-8	14-38	14-67/68	15-3	15-30	15A 5	15-34	15-40	15-49	17-1	17-8	17-15	16-4	16-9	16-19
Principal Constituent Minerals – percent																				
Aegirine-Augite						6	80	tr.?												
Apatite		1	4	5		6	2	6		5	9	6	8	2	11	tr.	4	6	2	3
Epidote	58	51	48	33	65	2		54	79	4	52	64	37	67	19	63	62	53	61	54
Garnet	3		2	tr.	tr.			1	tr.	tr.	1	9	5	15	8	15	20	14	14	8
Hornblende, Brn.		2	tr.	6		4	1	2	tr.	4										2
Hornblende, Grn.	18	29	35	40	23	71	14	34		72	tr.	tr.					tr.		tr.	21
Sphene							tr.?		tr.	tr.	11	2	15	1	19	5	1	5	6	tr.?
Tourmaline	1	1									3	4	4	2	5	5	2	1	tr.	3
Zircon	5	4	8	8	8	9	1	3	17	8	17	6	29	10	33	4	5	15	12	8
Minerals Present in Minor Amounts – percent																				
Andalusite		1								7	3	tr.?	tr.	1	1?	tr.?	tr.?	tr.	tr.	
Biotite	5	tr.				tr.			1		3	2	tr.	1	1		tr.		2	
Chlorite	2	2	3		tr.			tr.	tr.		1	1	tr.	tr.	2	4	3	3		1
Clinozoisite	8	7		4	2	2													1	
Corundum																tr.				
Glaucophane																			tr.	tr.
Hypersthene						tr?	2				tr?				tr.	1			1	
Kyanite				tr.								1			tr?					
Monazite	tr.?														tr.?					
Rutile									3							2?	1?	2	tr.	
Sillimanite												1							tr.	tr.
Staurolite		2	tr.	4	2	tr.						4	2?	1?	1?	1?	2?	1	1	tr.
Total	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

tr = trace
? = Questionable mineral identification

of garnet and sphene serve to contrast the middle unit from the upper unit. The mean abundance of zircon in the middle unit is about one third that in the upper unit and slightly less than that in the lower unit.

The upper unit includes all of the mineral species found in the two lower units, except aegirine-augite. The upper unit is distinguishable from the middle unit by its conspicuous lack of aegirine-augite. The greater amounts of garnet, sphene, and zircon in the upper unit distinguish it from the lower and middle units. Tourmaline is more commonly present in samples from the upper unit than those from the lower and middle units. The upper unit includes quantities of green and brown hornblende in some samples comparable to those found in the lower units, but the mean frequency of occurrence of these minerals in the upper unit is much less than in the underlying units.

Correlation of Results

Heavy-mineral residues from the Tertiary section exposed along Capps Glacier and the Chuitna River provide a basis for crude correlation between these rocks and major stratigraphic units in the Deep Creek Unit well on the Kenai Peninsula. The lower and middle stratigraphic units recognized in the sections along Capps Glacier are correlated with the West Foreland Formation. The occurrence of green hornblende differentiates the West Foreland Formation from the overlying formations in the Deep Creek Unit well (Kelley, 1973). On this basis, the heavy-mineral residues from the lower and middle stratigraphic units in the Tertiary rocks along Capps Glacier are best correlated with those from the West Foreland Formation in the Deep Creek Unit well. Biotite, chlorite, epidote, garnet, tourmaline, and zircon occur in the heavy-mineral residues from the West Foreland Formation in the Deep Creek Unit well and in those from the lower and middle stratigraphic units of the Capps Glacier section. The occurrence of large quantities of aegirine-augite in the middle stratigraphic unit is probably due to local volcanogenetic sedimentation as evidenced by the abundance of pyroclastic debris in these rocks (Adkison and others, 1975). The upper stratigraphic unit exposed near the toe of Capps Glacier and along the Chuitna River correlates with the Tyonek Formation and overlying rocks in the Deep Creek Unit well. A heavy-mineral suite characterized by apatite, biotite, chlorite, epidote, garnet, muscovite, sphene, tourmaline, and zircon occurs in the rocks above the Hemlock Conglomerate in the Deep Creek Unit well, and more closely approximates the heavy-mineral assemblage from the upper stratigraphic unit than the assemblages from the lower or middle stratigraphic units.

Comparison of heavy-mineral suites examined in this study and those reported from the Deep Creek Unit well does not provide a basis for recognition of the Hemlock Conglomerate among the Tertiary rocks exposed along Capps Glacier and the Chuitna River. The heavy-mineral suite from the Hemlock Conglomerate in the Deep Creek Unit well is characterized by 35 to 64 percent garnet, with no other mineral specie accounting for more than 20 percent of the sample. No sample examined in this study contains more than 20 percent garnet, and the mean value for garnet in the samples stratigraphically above those correlated with the West Foreland Formation is 9 percent.

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