STUDIES RELATED TO WILDERNESS
WILDLIFE REFUGES

EDMUNDS UNIT
MOOSEHORN REFUGE
MAINE

GEOLOGICAL SURVEY BULLETIN 1260-P

Summary Report on the Geology and Mineral Resources of the Edmunds Unit, Moosehorn National Wildlife Refuge Washington County Maine

By MAURICE H. PEASE, JR.

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A compilation of available geologic information

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STUDIES RELATED TO WILDERNESS

WILDLIFE REFUGES

The Wilderness Act (Public Law 88-577, Sept. 3, 1964) directs the Secretary of the Interior to review roadless areas of 5,000 contiguous acres or more, and every roadless island, within the national wildlife refuges and game ranges under his jurisdiction, and to report on the suitability or nonsuitability of each such area or island for preservation as wilderness. As one aspect of the suitability studies, existing published and unpublished data on the geology and the occurrence of minerals subject to leasing under the mineral leasing laws are assembled in brief reports on each area. This bulletin is one such report and is one of a series by the U.S. Geological Survey and the U.S. Bureau of Mines on lands under the jurisdiction of the U.S. Department of the Interior.

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SUMMARY REPORT ON THE GEOLOGY AND MINERAL RESOURCES OF THE EDMUNDS UNIT, MOOSEHORN NATIONAL WILDLIFE REFUGE, WASHINGTON COUNTY, MAINE

By MAURICE H. PEASE, JR.

Summary

The Edmunds Unit of the Moosehorn National Wildlife Refuge is an area of about 10 square miles in the Eastport quadrangle, Washington County, Maine. Bedrock in the area consists chiefly of volcanic rocks of the Dennys Formation but also includes exposures on Dog and Bitch Islands of the younger Edmunds Formation. Both formations are considered Silurian in age. Numerous diabase dikes intrude both formations, and granite is exposed in the western part of the area. Pleistocene deposits of till, outwash, and marine clay blanket most of the bedrock in the mainland area of the Edmunds Unit. The volcanic rocks strike northwest with a moderate to steep dip northeast; they are strongly jointed and fractured, and large-scale faulting may be present.

The Edmunds Unit lies in the northeastern part of a mineralized belt that parallels the coast of Maine, but no zones of intense alteration or significant mineral deposits have been osbserved within the unit. Most of the volcanic rocks are weakly altered, particularly along Hobart Stream. Sulfides are present almost exclusively as finely divided pyrite in minor fractures. Traces of chalcopyrite occur locally. Weakly anomalous geochemical values of copper, lead, mercury, silver, and gold were obtained from analyses of stream-sediment and rock samples from the area, but no significant patterns of distribution were observed.

Sand, gravel, and clay are the only known mineral resources of economic value within the Edmunds Unit. Gravel has been sold from the unit; however, sources of sand and gravel are abundant in surrounding areas. The igneous rocks underlying the unit are not likely to contain deposits of leasable minerals such as coal, oil, gas, phosphate, or potassium or sodium

compounds. Subsurface exploration would be necessary to determine whether commercial deposits of copper, lead, silver, and gold underlie the weak geochemical anomalies in the volcanic rocks.

INTRODUCTION

LOCATION AND GEOGRAPHY

Moosehorn National Wildlife Refuge, eastern Washington County, Maine, includes two small areas less than 25 square miles in total area—the Baring Unit and the Edmunds Unit. An area of about 10 square miles in the Edmunds Unit has been proposed for incorporation in the National Wilderness Preservation System (figs. 1 and 2). The area is roughly rectangular and is bounded on the northwest by Hobart Stream and on the east by U.S. Highway 1. It also includes Dog and Bitch Islands southeast of the village of Edmunds in Whiting Bay.

The relief of the area ranges from sea level to about 200 feet in the southwestern part. The low rounded hills have a poorly defined northwest-trending topographic grain that reflects bedrock structure. The principal drainage is Hobart Stream; minor tributary streams, originally areas of swamp, have been cleared and dammed to form ponds (fig. 2). Crane Mill Stream and Burnt Cove Brook head in the Edmunds Unit and flow southeastward into Whiting Bay.

The Edmunds Unit may be reached by U.S. Highway 1 from Machias, Washington County seat, about 20 miles to the southwest, and from the village of Pembroke about 8 miles to the north. A recently improved network of gravel roads provides access within the area.

In the absence of known mineral deposits, the U.S. Bureau of Mines has not had occasion to examine the Edmunds Unit, but the Bureau has been informed of the findings and conclusions of the Survey and concurs in them.

ACKNOWLEDGMENTS

Cooperation of the Bureau of Sport Fisheries and Wildlife is gratefully acknowledged. Mr. Stanley E. McCovey, who was in charge of the district office in Baring at the time of this investigation, was especially helpful by providing maps, aerial photographs, and a boat to visit Dog and Bitch Islands. Mr. William G. Cleaves, District Director of the Cobscook Bay State Park,

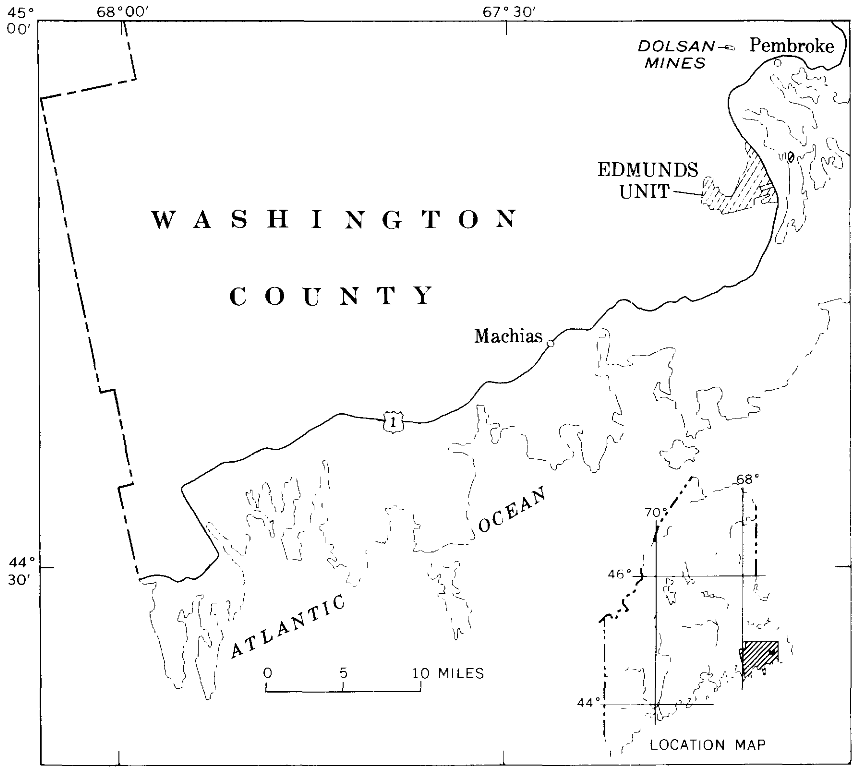

FIGURE 1.—Location of Moosehorn National Wildlife Refuge, Edmunds Unit, Washington County, Maine.

kindly permitted use of the State Park launching ramp. Thomas F. McGuire assisted the author in the field investigation.

Semiquantitative spectrographic analyses of stream and rock samples were made in the Denver laboratories of the Geological Survey by D. A. Grimes under the direction of A. L. Marranzino.

PREVIOUS STUDIES

The geology of the Eastport quadrangle, Maine, which includes the Edmunds Unit, was mapped by Bastin and Williams (1914) and published at a scale of 1:62,500. Gates (1961) mapped the geology of the Cutler and Moose River 7½-minute quadrangles immediately south of the Eastport quadrangle and is presently at work revising the geology of the Eastport quadrangle at a scale of 1:24,000.

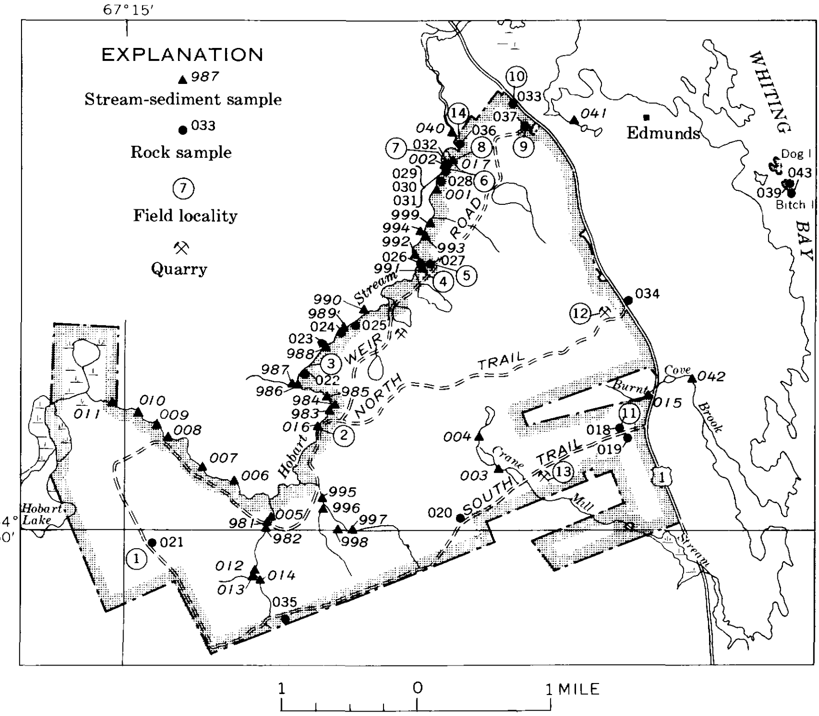

FIGURE 2.—Sample-locality map showing boundaries of Edmunds Unit. Samples are listed in table 1; field localities are discussed in text.

Bastin and Williams briefly mention the mineral resources of the area in the Eastport folio, but more detailed descriptions of many of the mineral deposits in the vicinity of the Edmunds Unit were made by Emmons (1910) and by Li (1942). The recent comprehensive evaluation of the mineral deposits of Washington County, Maine, by Young (1963) has greatly aided the writer in his evaluation of the mineral potential in the area. No mention has been made in the literature of specific mineral deposits or prospects within the Edmunds Unit.

PRESENT STUDIES

The present investigation of the Moosehorn National Wildlife Refuge, Edmunds Unit, was made during the 5-day period, August 29 to September 2, 1966, as part of a regional study of the geology and mineral resources of New England. A total of 62 stream-sediment and rock samples were collected for analyses, the results of which are recorded in table 1. No attempt was made to compile a geologic map of the area, but most of the outcrops were visited. Locations of analyzed samples are shown in figure 2.

Rock samples were studied under the microscope, and crushed grains from a few samples were examined petrographically, but no thin sections were made. All rock samples were stained with sodium cobaltinitrate to determine the presence or absence of minerals containing potassium.

GEOLOGY

OLDER ROCKS

The Edmunds Unit, according to the areal geologic map of the Eastport folio (Bastin and Williams, 1914), is almost entirely underlain by the Dennys Formation; a small area of no exposure in the southeast corner of the mainland area and on Dog and Bitch Islands are assigned to the overlying Edmunds Formation. Bastin and Williams consider both of the formations to be Silurian in age.

Dennys Formation

The Dennys Formation exposed within the Edmunds Unit consists chiefly of andesitic and possibly dacitic flows and volcanic breccia in which lithologic differences are difficult to distinguish and stratification is obscure or absent. Bedded fine-grained strata are interlayered locally with the massive volcanic rocks.

Bedrock exposures in Hobart Stream, between field localities 4 and 2 (fig. 2), consist mostly of massive andesite breccia that has been subjected to varied degrees of chloritic and argillic alteration with subsequent silicification. The rocks are greenish gray, commonly mottled to shades of light gray, and in places bleached almost white. The bleached rocks are flinty and fracture conchoidally. Ghost textures of the original rock are preserved even in the most altered rocks. Pyrite is sparsely distributed throughout these rocks, and traces of possible chalcopyrite were observed at several localities.

Well-bedded weakly calcareous tuffaceous sedimentary rocks are exposed in Hobart Stream at field locality 5 and between field localities 7 and 8. Siltstone and very fine grained sandstone at field localities 5 and 7 have an alteration similar to that characteristic of the volcanic rocks exposed upstream. Strata at field locality 8 appear to be less altered. They consist of dark gray, commonly pyritiferous siltstone alternating with medium- to coarse-grained highly calcareous beds in which fossil and pumice fragments are common.

These stratified rocks strike consistently about N. 40° W. and dip 30° NE. but were not observed beyond the immediate vicinity of Hobart Stream and apparently do not extend as far southeast as Weir Road. Exposures in the stream were insufficient to determine the stratigraphic relations of these rocks to each other or to the massive volcanic rocks that make up most of the Dennys Formation in the Edmunds Unit.

Most of the rocks exposed southeast and east of field locality 14 on Hobart Stream to a point beyond U.S. Highway 1 consist of massive highly jointed flow rock; this is freshly exposed in a small roadcut at field locality 9. The flow rock contains 15 percent well-defined plagioclase phenocrysts set in a dark-gray aphanitic groundmass and also contains traces of green chlorite. The rock characteristically weathers brownish to almost pinkish gray, and the plagioclase phenocrysts weather to a light orange. Sodium cobaltinitrate stains the groundmass greenish yellow, particularly where the rock is slightly weathered. Petrographic examination of crushed grains of the phenocrysts showed them to be cloudy untwinned albite coated with brown clayey material.

Bastin and Williams (1914, p. 3) describe the character of the Dennys Formation. "The principal rock of the formation is rhyolite, of several types, occurring as flows and tuffs. Interbedded and otherwise closely associated with the rhyolite are several varieties of andesite, also in flows and tuffs. Diabase flows and tuffs also occur but are of relatively minor importance. The effusive rocks have been disturbed by the intrusion of masses of diabase and of andesite and possibly also of rhyolite."

Rhyolite may well be the principal rock type of the Dennys Formation, but at least in the Edmunds Unit rhyolite appears to be rare or absent. Nowhere have quartz or potassium-feldspar phenocrysts been observed in these rocks. The weakly effective sodium cobaltinitrate staining of the groundmass of these lavas is attributed to the presence of potassium in clays formed by devitrification of glass. Most of the Dennys Formation in the Edmunds Unit appears to be slightly altered andesite and possibly some dacite.

Edmunds Formation

The contact between the Dennys and overlying Edmunds Formation on the geologic map of the Eastport folio lies almost entirely east of U.S. Highway 1. It was not observed during this investigation. Exposures of the Edmunds Formation within the Edmunds Unit have been observed only on Dog and Bitch Islands where thin planar-bedded calcareous tuffaceous siltstone is interlayered with massive- to thick-bedded lapilli tuff and tuff breccia. The coarse tuffaceous rocks, which are the dominant rock type on both islands, are well exposed at the southern tip of Bitch Island. The rock consists of fragments of porphyritic lava, pumice, and limestone in a brownish-gray highly calcareous matrix. Thin-bedded calcareous tuffs are well exposed along the northeast shore of Bitch Island and apparently underlie most of the northeast lobe of Dog Island. They strike N. 30°–50° W. and dip 30°–55° NE. These well-stratified rocks characteristically contain angular fragments of dark-gray pumice and aphanitic lava, as much as an inch in diameter, which are concentrated in beds alternating with beds of fine-grained calcareous tuff. Abundantly fossiliferous calcareous tuffaceous siltstone is exposed near the northern end of Bitch Island. A few representative fossil casts were collected, but these have not been identified. The rocks on Dog and Bitch Islands show little evidence of the alteration that has affected the Dennys Formation in Hobart Stream.

According to Bastin and Williams (1914), "The most abundant rock of the Edmunds Formation is rhyolite, both gray and red, which forms flows and associated tuffs. The next most abundant rock *** is purplish-red andesite occurring as flows and tuffs ***." They also state that diabase flows and tuffs take the place of andesite toward the southwest and that diabase tuffs are best exposed on Bitch Island. Their geologic map shows a thin band of diabase tuff on the northeast side of Dog and Bitch Islands in contact with undifferentiated Edmunds Formation to the west. Evidently the diabase refers to the thin-bedded rocks; the undifferentiated rocks, to massive lapilli tuff and breccia. There does not, however, appear to be any significant compositional difference between the two units and fine-grained thin-bedded tuffs are interlayered with the massive rocks even on the south side of the island.

Diabase

Intrusive diabase dikes occur abundantly in the Edmunds Unit both on the mainland and on Dog and Bitch Islands. These are massive dark-greenish-gray rocks composed chiefly of plagioclase, dark-green hornblende, and pyroxene. Etched surfaces reveal a distinctly diabasic texture. Composition and texture of the diabase are remarkably similar wherever exposed. The rock is essentially holocrystalline and has minor amounts of interstitial chlorite; grain size varies from fine to medium.

Within the Edmunds Unit, diabase occurs exclusively as tabular dikes from 5 to 40 feet wide oriented parallel to prominent joint sets with no apparent relation to stratification. These dikes are resistant units in outcrop, and their nearly vertical contacts commonly are well exposed. Dikes trend in several directions but most trend about N. 70°–80° W. Several dikes can be traced in discontinuous outcrop for more than one-half mile with remarkably little change in direction or thickness. Bastin and Williams consider that the age of most of the diabase is Late Silurian or Early Devonian, older than the Upper Devonian Perry Formation, but that some may be as young as Triassic.

Granite

Granitic rock was observed at only one locality in the Edmunds Unit; it crops out in a small exposure less than 10 feet in diameter on the North Trail near the western border. The granite is holocrystalline and mottled gray and pinkish gray. It is composed of plagioclase, potassium feldspar, hornblende, and quartz. Subhedral stubby plagioclase crystals 3–5 mm in diameter are of untwinned dirty albite. Somewhat smaller pink potassium-feldspar crystals, which stain bright yellow with sodium cobaltinitrate, appear to be interstitial to the plagioclase. Hornblende, also interstitial, has been partly chloritized.

This granite probably correlates with the granite of Bastin and Williams (1914) that lies just west of the Eastport quadrangle. As outcrops are rare in the western part of the Edmunds Unit, it is possible that a large part of this area is underlain by the granite. Bastin and Williams (1914) assign a Late Silurian to Late Devonian age to the granite on the basis of granite pebbles found in basal beds of the Upper Devonian Perry Formation. Li (1942) considers that this granite is the source of the mineralizing solutions that formed all the metallic mineral deposits of eastern Maine.

SURFICIAL DEPOSITS

Pleistocene deposits of till, outwash, and marine clay blanket most of the Edmunds Unit. Bedrock is exposed in less than 2 percent of the area. Most of the upland areas are underlain by glacial till, and the lowlands are underlain by marine clays having thin veneers of more recent alluvium. Outwash occurs in relatively large isolated deposits.

The till consists of poorly consolidated and poorly sorted cobble-, boulder-, sand-, silt-, and clay-size fractions. The till is mostly sandy rather than clayey.

The outwash deposits range in thickness from 0 to 40 feet. Most deposits are composed of well-stratified medium- to light-gray somewhat silty fine to coarse sand and minor amounts of gravel. Locally, small patches of poorly sorted coarser outwash gravels consist chiefly of well-rounded pebbles and cobbles and a few boulders.

The best exposure of an outwash deposit was observed in the largest gravel pit within the Edmunds Unit at field locality 13. In this pit, a section about 30 feet high consists mostly of thin alternate beds of coarse, medium, and fine sand. Thin beds and channel fillings of pebble to cobble gravel are interlayered with the sand, particularly near the top of the northeast face of the pit. Bedding varies in strike, and dips about 15° S.; no evidence of a foreset-topset relation was observed in this pit. In the gravel pit at field locality 12, a 20-foot-thick section of outwash sand and gravel rests on glacially striated bedrock. The striations trend N. 40°–45° W.

The marine clays are only poorly exposed, chiefly in the banks of streams and in one or two low roadcuts. These clays are somewhat silty, greenish gray when wet, but commonly very light gray when dry.

On the surficial geologic map of the Eastport folio, the 100-foot contour marks an approximate division between marine clay below and glacial till above. Marine-glacial sand and gravel, or deposits of outwash, are present locally in the broad area between the 60- and 160-foot contours. Marine clay underlies roughly 60 percent of the area, glacial till 30 percent, and marine sand and gravel 10 percent. Estimates made during the present investigation are in general accord with these percentages except that the amount of sand and gravel may be somewhat less.

STRUCTURE

The stratified rocks of the Edmunds Unit strike rather uniformly N. 35°–50° W., and except for local steepening, they dip moderately northeastward. Thus, the attitude of bedding is indicative of an undisturbed monoclinal sequence, but in a large part of the mainland area no evidence for stratification was observed. Moreover, the distribution of rock types, particularly the limited lateral extent of the bedded rocks in Hobart Stream, suggests that faults of considerable displacement may extend through the Edmunds Unit. The area is highly fractured. Joints are abundant, and minor faults have been observed in several outcrops.

Faults

Fault surfaces observed in outcrop are slickensided and commonly are coated with secondary minerals. On several faults the slickensides show directions of latest movement, but there is no apparent preferred orientation, and the amounts of displacement could not be determined.

A fault has been postulated at field locality 11 where, within a few yards, dips of thinly banded ash-flow(?) deposits change from 40° NE. to steeply overturned to the west. The steeply dipping strata are silicified and tightly jointed. Traces of sulfide and strong limonite staining are conspicuous in these fractured rocks. The importance of this fault is not known; its trend is suggested only by a change in strike from N. 30° W. to N. 70° W.

According to Bastin and Williams (1914), a north-trending fault, offset by several cross faults, forms the contact between the Dennys and Edmunds Formations east of U.S. Highway 1. This contact relation was not confirmed during the present investigation.

Joints

The most prominent joint set trends west-northwest, which is also the principal orientation of the diabase dikes. This preferred orientation is most conspicuous in the northern part of the mainland area and on Dog and Bitch Islands. An important but poorly defined joint set along Hobart Stream strikes northeast and dips steeply west. Contacts between bleached and unbleached altered volcanic rocks commonly are healed fractures that parallel this set.

MINERAL RESOURCES

Sand and gravel are the only mineral resources known in the Edmunds Unit of the Moosehorn National Wildlife Refuge. The area may, however, be of interest to prospectors because minor geochemical anomalies for copper, lead, silver, gold, and mercury occur in the area.

METALLIC MINERALS

Regional Setting

The Edmunds Unit is in the northeastern part of a mineralized belt, about 15 miles wide, that parallels the coast of Maine. The belt has been prospected and mined at intervals since the latter part of the 19th century. Although no mineral occurrences have been reported from the Edmunds Unit, several prospects are known within a 15-mile radius, and exploration presently is in progress at the Dolsan Mines, Ltd., about 6 miles to the north.

Emmons (1910) described three types of deposits in this belt: those formed before regional metamorphism, those associated with granite intrusion, and those associated with more mafic intrusion. Li (1942) reported that most of these deposits are of the vein type and that they are all genetically related to a granite body that is Late Silurian to Middle Devonian in age. Recent geologic investigations suggest that this mineral belt may occur in a regional northeast-trending zone of faults along which mafic and felsic intrusive igneous rocks and related mineralizing solutions were introduced.

Dolsan Mines

The Dolsan Mines property, about 6 miles north of the Edmunds Unit (fig. 1), was examined in order to compare rocks and minerals of that area with those in the unit. Two mineralized zones are present at Dolsan Mines—the Barrett copper-gold zone and the Big Hill zinc-lead-silver zone. The Barrett zone occurs in brecciated and silicified volcanic rocks assigned to the Dennys Formation (Bastin and Williams, 1914), and the Big Hill zone seems to occur in the Pembroke Formation and to be associated with diabase intrusion.

Geophysical surveys of these zones made in 1963 were mostly unsuccessful (Young, 1963). The Barrett zone showed a small but high-value self-potential anomaly which trends northeast.

Results of self-potential and electromagnetic surveys on the Big Hill zone were negative. Young (1963) states, however, that "Geochemical data in this particular area appears to be especially significant."

A large exploration trench across the Barrett zone was visited briefly by the writer. The main brecciated zone trends northeast and is at least 40 feet wide. Sphalerite and chalcopyrite occur in an anastamosing system of fractures within the zone. Also exposed in the trench is a north-trending shear zone and several parallel zones containing copper minerals associated with gold and silver.

The writer did not visit the Big Hill zone. According to Young (1963), sulfide minerals containing silver occur in several veins or zones in fractured volcanic rock and shale in the vicinity of a large diabase mass.

Alteration and Mineralization—Edmunds Unit

No zones of intense alteration or mineral deposition have been observed in the Edmunds Unit; however, the geologic setting has features characteristic of other mineralized areas in eastern Maine. The weakly altered andesite in the Edmunds Unit is lithologically similar to the rocks exposed in the trench across the Barrett zone of the Dolsan Mines.

The altered volcanic rocks consist chiefly of quartz, albite, and chlorite. Muscovite (or sericite) is conspicuously absent, but clay minerals have been observed, and clay probably is a common interstitial component. Epidote and pyrite are present locally. This mineral assemblage is typical of the propylitic facies of hydrothermal alteration (Lovering, 1949; Creasey, 1959), which is characteristic of the outer fringes of altered areas of the kind associated with many ore deposits.

Sulfides are present almost exclusively as finely divided pyrite in minor fractures that show no apparent preferential orientation. Traces of chalcopyrite occur with pyrite locally in Hobart Stream (field locs. 3 and 8) and elsewhere (field loc. 10). In the exposure (field loc. 10) on U.S. Highway 1 near the extreme northeast corner of the area, chalcopyrite occurs in a vertical veinlet a quarter inch thick that trends N. 65° W. The most prominent joint set in this outcrop trends N. 15° W. and dips 80° SW. Slickensides on several of these joints indicate at least minor dislocation; they plunge about 20° S., and the west wall appears to have moved down to the south. The trend of this joint set is about parallel to the mineralized shears in the Barrett zone. Several strongly silicified zones in Hobart Stream appear to trend northeast about parallel to the regional trend of the mineralized belt.

Analytical Data

Rock and stream-sediment samples were taken to test for evidence of mineral deposits of the type found elsewhere in southeastern Maine. The locations of these samples are shown in figure 2, and the results of analyses are listed in table 1.

The normal or background level of metal content was determined by averaging the abundance in analyzed stream-sediment samples. Several samples were collected from just outside the Edmunds Unit to insure complete coverage. A sample (038) of ore from the trench in the Barrett zone of the Dolsan property was analyzed for comparison.

Analyses of diabase samples show titanium, vanadium, nickel, cobalt, and chromium but in amounts characteristic of these mafic igneous rocks and not indicative of abnormal mineral content. Presence of weakly anomalous amounts of these metals in stream-sediment samples probably is indicative of a diabase exposure upstream.

The anomalous values for copper, lead, mercury, silver, and gold are shown separately (fig. 3). No significant patterns of metallic sulfide distribution were observed. The zinc and molybdenum values are not significantly above background.

The traces of copper and lead probably occur as sulfides with pyrite in the volcanic rocks of the Edmunds Unit. One sample (033), from the only vein in which chalcopyrite was observed (field loc. 10), has a copper content 67 times background and a silver content at least 15 times background, comparable to concentrations in ore from the Barrett-zone trench. All other copper values are only slightly greater than twice background. Most lead values also are only slightly more than twice background, but the high values (four to five times background), of rock samples 026 and 027 suggest that galena may be present in the pyritic beds of Hobart Stream. The significance of the only other silver anomaly, stream-sediment sample 036, is not known.

TABLE 1.—*Analytical data, Moosehorn*

Sample	Semiquantitative spectrographic analyses (ppm)																	
	Ti	Zn	Mn	V	Zr	La	Ni	Cu	Cd	Pb	B	Y	Mo	Sn	Co	Ag	Be	Bi
							Stream sediment samples											
981	5000	<200	1000	100	150	<20	20	50	<20	50	10	20	<2	<10	5	<0.5	<1	<10
982	5000	<200	500	100	200	<20	10	50	<20	50	10	20	<2	<10	5	<.5	<1	<10
983	7000	<200	1000	200	200	<20	10	50	<20	20	10	20	<2	<10	10	<.5	<1	<10
984	5000	<200	1000	100	200	<20	20	50	<20	10	10	20	<2	<10	10	<.5	<1	<10
985	5000	<200	1000	100	200	<20	10	100	<20	10	<5	20	<2	<10	5	<.5	<1	<10
986	5000	<200	1000	100	200	<20	50	50	<20	10	20	20	<2	<10	50	<.5	<1	<10
987	10,000	<200	500	50	150	<20	20	100	<20	10	<5	20	<2	<10	20	<.5	<1	<10
988	7000	<200	500	100	200	<20	20	100	<20	10	10	20	<2	<10	50	<.5	<1	<10
989	7000	<200	500	100	200	<20	20	100	<20	10	10	20	2	<10	20	<.5	<1	<10
990	2000	<200	500	50	100	<20	10	50	<20	20	<5	<5	<2	<10	<5	<.5	<1	<10
991	3000	<200	200	50	200	<20	10	100	<20	20	10	20	<2	<10	5	<.5	<1	<10
992	5000	<200	500	50	200	<20	10	50	<20	20	10	10	<2	<10	5	<.5	<1	<10
993	7000	<200	500	100	500	<20	20	50	<20	10	10	20	<2	<10	10	<.5	<1	<10
994	7000	<200	500	70	200	<20	10	20	<20	10	10	20	<2	<10	10	<.5	<1	<10
995	5000	<200	1000	150	200	<20	10	20	<20	10	<5	10	<2	<10	20	<.5	<1	<10
996	10,000	<200	500	100	100	<20	20	50	<20	10	<5	20	<2	<10	20	<.5	<1	<10
997	5000	<200	500	70	100	<20	20	50	<20	20	<5	20	<2	<10	20	<.5	<1	<10
998	5000	<200	1000	100	150	<20	20	100	<20	20	10	20	2	<10	50	<.5	<1	<10
999	5000	<200	500	70	100	<20	10	50	<20	10	<5	10	2	<10	10	<.5	<1	<10
001	2000	<200	500	50	100	<20	10	100	<20	10	<5	20	<2	<10	10	<.5	<1	<10
002	1500	<200	500	100	100	<20	20	20	<20	10	10	20	<2	<10	10	<.5	<1	<10
003	5000	<200	200	50	100	<20	10	50	<20	10	<5	10	<2	<10	5	<.5	<1	<10
004	5000	<200	200	50	100	<20	10	20	<20	20	<5	20	<2	<10	5	<.5	<1	<10
005	3000	<200	500	70	100	50	15	20	<20	10	<5	20	<2	<10	5	<.5	<2	<10
006	3000	<200	700	70	100	<20	20	20	<20	10	<5	20	<2	<10	5	<.5	<2	<10
007	5000	<200	700	100	150	<20	20	10	<20	10	<5	20	<2	<10	5	<.5	<2	<10
008	3000	<200	500	70	100	<20	15	5	<20	10	<5	20	<2	<10	5	<.5	<2	<10
009	2000	<200	500	50	100	<20	10	5	<20	10	<5	10	<2	<10	<5	<.5	<2	<10
010	3000	<200	500	100	150	20	20	5	<20	10	<5	20	<2	<10	5	<.5	<2	<10
011	3000	<200	300	70	150	<20	10	5	<20	10	<5	20	<2	<10	<5	<.5	<2	<10
012	3000	<200	500	70	100	<20	10	5	<20	10	<5	20	<2	<10	5	<.5	<2	<10
013	3000	<200	1000	100	150	<20	20	5	<20	20	<5	20	2	<10	30	<.5	<2	<10
014	5000	<200	1000	100	150	<20	10	10	<20	50	<5	2	2	<10	20	<.5	<2	<10
015	3000	<200	700	100	150	<20	20	5	<20	20	<5	20	<2	<10	10	<.5	<2	<10
016	3000	<200	2000	70	150	<20	30	5	<20	10	<5	20	2	<10	20	<.5	<2	<10
017	2000	<200	2000	50	100	<20	20	5	20	50	<5	10	2	<10	10	<.5	<2	<10
								Rock samples										
018	2000	<200	500	20	100	50	<2	2	<20	<10	<5	10	<2	<10	10	0.5	<2	<10
019	2000	<200	500	50	150	50	<2	3	<20	<10	<5	50	<2	<10	<5	<.5	<2	<10
020	7000	<200	1000	150	70	50	100	10	<20	<10	<5	10	2	<10	30	<.5	<2	<10
021	5000	<200	700	70	100	<20	2	5	<20	<10	<5	30	<2	<10	10	<.5	<2	<10
022	10,000	<200	1000	200	70	50	20	5	<20	<10	<5	30	2	<10	20	<.5	<2	<10
023	5000	<200	1000	150	70	<20	20	10	<20	<10	<5	30	2	<10	10	<.5	<2	<10
024	2000	<200	700	70	150	<20	30	20	<20	<10	<5	30	<2	<10	10	<.5	<2	<10
025	2000	<200	500	50	100	50	10	5	<20	10	<5	30	<2	<10	10	<.5	<2	<10
026	3000	<200	500	50	100	50	20	5	<20	70	<5	20	2	<10	10	<.5	<2	<10
027	3000	<200	1000	50	100	20	10	5	<20	100	<5	50	2	<10	5	<.5	<2	<10
028	1500	<200	1000	<10	500	50	<2	2	<20	10	<10	50	<2	<10	<5	<.5	<1	<10
029	5000	<200	1500	70	150	50	5	2	<20	<10	<10	100	<2	<10	5	<.5	<1	<10
030	1500	<200	1500	<10	500	50	<2	5	<20	<10	<10	50	<2	<10	<5	<.5	<1	<10
031	5000	<200	1000	150	150	50	2	50	<20	<10	<10	200	<2	<10	<5	<.5	<1	<10
032	5000	<200	1000	100	200	<20	20	20	<20	50	20	50	<2	<10	10	<.5	<1	<10
033	2000	<200	500	20	500	50	<2	5000	<20	<10	<10	50	2	<10	<5	15	<1	<10
034	2000	<200	1000	150	100	<20	10	100	<20	10	<10	20	<2	<10	10	<.5	<1	<10
035	1500	<200	200	<10	200	100	<2	5	<20	<10	<10	30	<2	<10	<5	<.5	<1	<10
036	2000	<200	500	20	200	100	<2	10	<20	<10	<10	50	<2	<10	<5	5	<1	<10
037	2000	<200	500	20	200	100	<2	5	<20	<10	<10	50	<2	<10	<5	<.5	<1	<10
038	2000	<200	10000	50	100	<20	<2	5000	50	70	20	20	50	<10	5	2	<1	20
039	10,000	<200	1000	200	100	<20	100	70	<20	<10	20	30	2	<10	70	<.5	<1	<10
040	5000	<200	500	70	150	20	20	2	<20	<10	50	20	<2	<10	5	<.5	<1	<10
041	5000	<200	1000	70	150	<20	20	2	<20	50	50	30	<2	<10	5	<.5	<1	<10
042	7000	<200	1000	100	150	<20	30	2	<20	20	50	30	<2	<10	5	<.5	<1	<10
043	5000	<200	1000	50	100	20	<2	2	<20	10	<10	50	<2	<10	<5	<.5	<1	<10

National Wildlife Refuge, Edmunds Unit, Maine

	Semiquantitative spectrographic analyses--Continued (ppm)											(percent)			
Sample	Ga	As	Sb	W	Sc	Cr	Ba	Sr	Au	Ag	Hg	Fe	Mg	Ca	Sample description
								Stream sediment samples--Continued							
981	20	<100	<100	<50	50	50	500	100	<.1	0.7	60	2	2	1	Stream sediment.
982	20	<100	<100	<50	50	70	500	100	<.1	.7	40	2	1.2	1.5	Do.
983	20	<100	<100	<50	50	70	500	100	<.1	.7	80	7	5	1.5	Do.
984	10	<100	<100	<50	20	70	200	100	<.1	.7	50	5	2	1.5	Do.
985	10	<100	<100	<50	20	70	200	100	<.1	.7	50	5	5	1	Do.
986	10	<100	<100	<50	50	70	200	100	<.1	.7	40	5	1.5	1	Do.
987	10	<100	<100	<50	50	70	150	150	<.1	.7	50	5	5	1.5	Do.
988	20	<100	<100	<50	50	70	200	200	<.1	.7	50	7	5	1	Do.
989	20	<100	<100	<50	50	50	200	200	<.1	.8	40	5	2	2	Do.
990	10	<100	<100	<50	20	20	200	150	<.1	.7	50	2	1	1	Do.
991	10	<100	<100	<50	20	50	200	150	<.1	.8	50	2	1	1	Do.
992	10	<100	<100	<50	20	50	200	150	<.1	.8	40	2	1	1	Do.
993	10	<100	<100	<50	50	70	200	200	<.1	<.1	60	5	2	2	Do.
994	10	<100	<100	<50	20	70	200	200	<.1	<.1	70	2	1.5	1	Do.
995	10	<100	<100	<50	50	70	150	200	<.1	<.1	60	7	5	2	Do.
996	15	<100	<100	<50	50	100	150	200	<.1	<.1	30	5	2	2	Do.
997	15	<100	<100	<50	20	100	200	200	<.1	.7	40	7	5	1	Do.
998	10	<100	<100	<50	20	100	150	200	<.1	.7	70	10	5	1	Do.
999	10	<100	<100	<50	50	70	500	200	<.1	.7	50	5	2	2	Do.
001	10	<100	<100	<50	20	50	200	100	<.1	.7	40	2	1.5	1	Do.
002	20	<100	<100	<50	30	50	200	150	<.1	.7	40	7	1.5	1	Do.
003	10	<100	<100	<50	50	50	500	100	<.1	.7	80	5	2	1	Do.
004	10	<100	<100	<50	20	50	500	100	<.1	.8	80	5	2	1.5	Do.
005	10	<200	<100	<50	20	70	500	200	<.1	.8	20	3	2	1	Do.
006	10	<200	<100	<50	50	70	200	200	<.1	<.1	37	5	2	1	Do.
007	20	<200	<100	<50	30	70	200	100	<.1	<.1	37	5	2	1.5	Do.
008	10	<200	<100	<50	20	50	200	100	<.1	.7	50	5	2	1	Do.
009	10	<200	<100	<50	20	20	200	100	<.1	.7	30	2	1	1	Do.
010	10	<200	<100	<50	50	70	500	200	<.1	.8	40	5	2	1.5	Do.
011	10	<200	<100	<50	30	50	200	150	<.1	.8	50	5	2	1	Do.
012	20	<200	<100	<50	30	50	200	200	<.1	.8	30	3	2	1	Do.
013	10	<200	<100	<50	30	70	200	100	<.1	.8	110	7	1	.5	Do.
014	10	<200	<100	<50	70	50	100	200	<.1	.8	40	7	2	1	Do.
015	10	<200	<100	<50	50	50	200	200	.1	.8	50	5	1	1	Do.
016	10	<200	<100	<50	20	50	150	100	.2	.8	40	5	1	.5	Do.
017	20	<200	<100	<50	30	70	150	100	.2	.8	50	5	1	.5	Do.
								Rock samples--Continued							
018	10	<200	<100	<50	10	<10	500	200	<0.1	0.7	20	2	0.5	0.5	Ash flow.
019	20	<200	<100	<50	10	<10	500	200	<.1	.8	20	3	.5	.5	Do.
020	30	<200	<100	<50	100	200	50	500	<.1	.8	<10	7	7	10	Diabase.
021	50	<200	<100	<50	50	<10	500	500	<.1	.8	<10	5	2	2	Granite.
022	30	<200	<100	<50	100	50	100	500	<.1	<.1	<10	10	7	10	Diabase.
023	20	<200	<100	<50	100	<10	150	500	<.1	.7	10	5	5	2	Altered volcanic rock.
024	20	<200	<100	<50	20	50	50	200	.2	<.1	4	7	5	1	Do.
025	10	<200	<100	<50	50	<10	200	500	.1	.7	20	5	3	2	Do.
026	20	<200	<100	<50	50	20	500	500	<.1	.7	10	5	2	2	Bedded tuffaceous rock.
027	10	<200	<100	<50	20	<10	200	500	.1	.8	10	5	1	5	Do.
028	10	<200	<100	<50	20	<5	200	100	<.1	.8	<10	5	.5	2	Altered volcanic rock.
029	10	<200	<100	<50	100	70	1500	700	<.1	.8	10	10	.7	2	Do.
030	10	<200	<100	<50	20	<5	500	100	.1	.8	10	7	1	1	Do.
031	10	<200	<100	<50	50	50	1000	700	<.1	.8	10	5	.5	1.5	Do.
032	20	<200	<100	<50	50	70	500	200	<.1	.7	20	10	5	5	Bedded tuffaceous rock.
033	20	<200	<100	<50	20	20	500	100	<.1	100	40	5	.2	1	Altered volcanic rock.
034	10	<200	<100	<50	50	50	100	500	<.1	.8	20	5	2	5	Do.
035	10	<200	<100	<50	<5	<5	500	200	<.1	.7	<10	2	.2	1	Do.
036	20	<200	<100	<50	20	20	500	200	<.1	<.1	<10	5	.5	1	Massive flow rock.
037	10	<200	<100	<50	20	20	500	100	.1	<.1	10	2	.5	2	Do.
038	50	<200	<100	<50	20	10	500	<50	<.1	.8	100	10	10	.1	Altered volcanic rock.
039	20	<200	<100	<50	100	500	50	500	<.1	<.1	20	10	10	10	Diabase.
040	10	<200	<100	<50	50	150	500	200	<.1	.7	30	7	2	2	Stream sediment.
041	20	<200	<100	<50	20	150	200	200	.1	.8	20	10	.5	1	Do.
042	20	<200	<100	<50	50	200	200	200	<.1	.8	20	10	5	1.5	Do.
043	20	<200	<100	<50	20	20	700	500	.1	.8	10	5	1	2	Massive tuff.

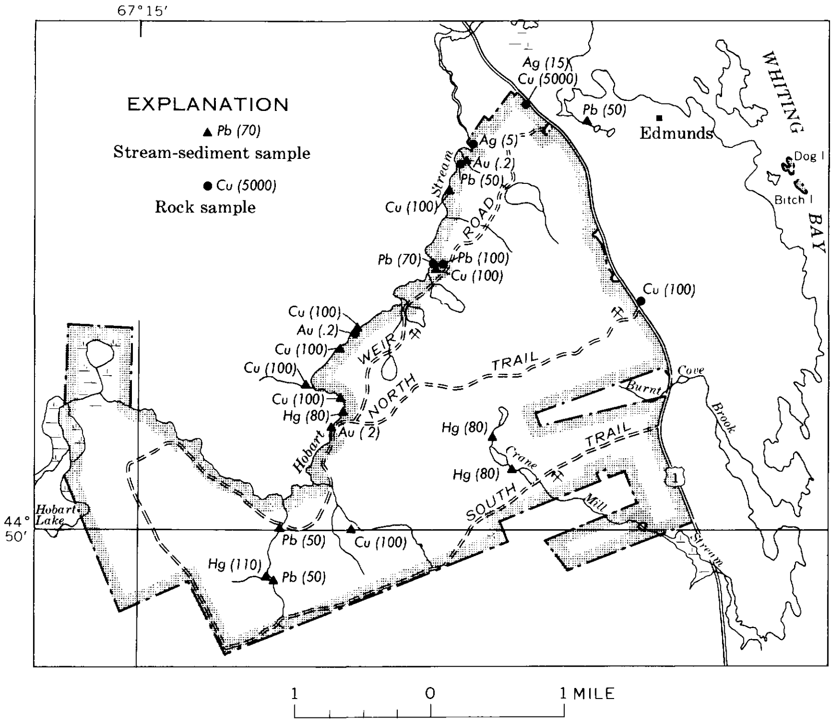

FIGURE 3.—Samples having at least twice the background amount of copper, lead, gold, silver, or mercury; values in parentheses are in parts per million.

No sulfide minerals were observed in this sample, and no anomaly was detected in the atomic-absorption analysis of this sample. Of the four mercury samples considered to be anomalous, three are slightly less than twice background and one slightly more. All are from stream-sediment samples in the area of altered volcanic rock, but owing to the volatile nature of mercury, it is difficult to assess the importance of these weak anomalies.

NONMETALLIC MINERALS

Nonmetallic mineral deposits in the Edmunds Unit and in the surrounding area consist exclusively of sand, gravel, and clay.

Sand and Gravel

All the larger sand and gravel deposits shown in figure 4 were briefly visited but were not studied in detail. Rough estimates indicate a total reserve of about 25 million cubic yards. The Fish

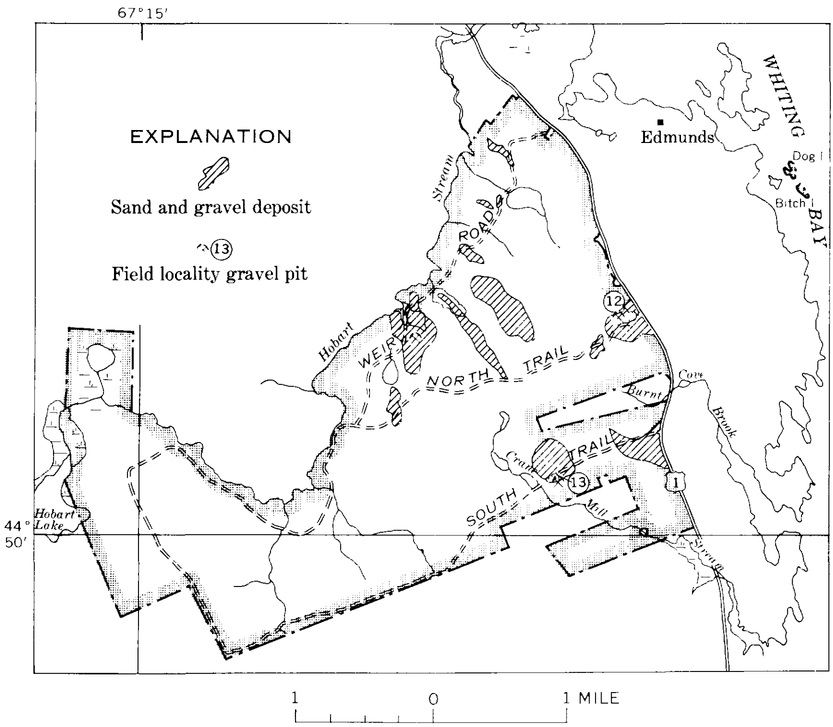

FIGURE 4.—Map of Edmunds Unit showing distribution of the principal deposits of sand and gravel, modified from Eastport folio (Bastin and Williams, 1914).

and Wildlife Service reports that sales of these gravels in the past 10 years have amounted to more than $25,000. Sand and gravel deposits occur in abundance in the area surrounding the Edmunds Unit.

Clay

Marine clay blankets much of the Edmunds Unit. Many deposits are thick enough to be mined and are of a quality suitable for the manufacture of brick. Equally extensive deposits exist nearby, however, outside the Edmunds Unit, and these apparently have not been worked during the present century.

CONCLUSIONS

The only known mineral resources of possible economic value in the Edmunds Unit of the Moosehorn National Wildlife Refuge are deposits of sand, gravel, and clay. These materials may be obtained with equal or better facility from nearby areas. The Edmunds Unit lies within a metallic-minerals province and rocks within the unit have certain features characteristic of mineralized areas within the province; however, these rocks are not strongly altered, and the weak geochemical anomalies within them do not show significant patterns of metal distribution. Subsurface exploration would be necessary to determine whether commercial deposits underlie the geochemically anomalous areas.

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