ISLE ROYALE NATIONAL PARK
GEOLOGIC RESOURCES MANAGEMENT ISSUES
SCOPING SUMMARY

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Executive Summary

A Geologic Resource Evaluation scoping meeting for Isle Royale National Park as held at park headquarters on Mott Island June 16, 2004. The scoping meeting participants identified the following as the most significant geologic resources management issues.

1. Park wants to know the submerged geomorphology using LIDAR and other appropriate techniques.

2. Identify ancient shorelines in an effort to study early history.

3. Identify old mining sites

4. Park would like a new source of drinking water, preferably from a water well.

Introduction

The National Park Service held a Geologic Resources Evaluation scoping meeting for Isle Royale National Park (ISRO) at park headquarters on Mott Island on Wednesday, June16, 2004. The purpose of the meeting was to discuss the status of geologic mapping in the park, the associated bibliography, and the geologic issues in the park. The products to be derived from the scoping meeting are: (1) Digitized geologic maps covering ISRO; (2) An updated and verified bibliography; (3) A scoping summary (this report); and (4) A Geologic Resources Evaluation Report which brings together all of these products.

Isle Royale National Park was established on March 3, 1931. It was designated a Biosphere Reserve in 1980. Total area of the park is about 571,790 acres, of which land area is 133,782 acres. The park is open from April 16 through October 31, and closed from November 1 through April 15.

There are 19 quads of interest covering Isle Royale National Park. From northeast to southwest they are: Passage Island OE ("Over Edge") North, Passage Island, Rock Harbor Lodge, Belle Harbor, Mott Island, McCargoe Cove, Lake Richie, Lake Richie OE South, Todd Harbor, Malone Bay, Little Todd Harbor, Point Houghton, Point Houghton OE South, Sugar Mountain, Feldtmann Ridge, Windigo, Feldtmann Lake, Windigo OE West, and Feldtmann Lake OE West. Of these, Passage Island OE N, Passage Island, Windigo OE W and Feldtmann Lake OE W are entirely off-shore.

Four known geologic maps cover ISRO, three in 1973 by N. King Huber: map I-796, scale 1:62,500 (Huber, 1973), Professional Paper 754-A, scale 1:120,000 (Huber, 1973), and Professional Paper 754-B, scale 1:62,500 (Wolff and Huber, 1973). Open-File Report OF-03-276, scale 1:100,000, is a map of the bedrock, soil and lichen geochemistry (Woodruff, et. al., 2003). The NPS Geologic Resources Division will digitize the Huber map of glacial deposits (Professional Paper 754-A) as well as the I-796, for basic geologic coverage. By using the two

maps together, the locations of the Copper Harbor Conglomerate can be plotted more accurately. A third order soil survey was done in the 1980s and published in June 1991. At present ISRO contracts with Michigan Tech in Houghton to produce all of their data layers for their park. There is also a need to look at available bathymetric data.

Physiography

Isle Royale is about 45 mile long and nine miles wide at its widest point (see attached map). It lies in the northern end of Lake Superior, 73 miles north of Houghton, MI and 56 miles north of Copper Harbor, MI. It is about 22 miles east of Grand Portage, MN. and only 15 miles southeast of the Canadian shoreline. The park is composed of one large island and about 400 small islands.

It is apparent, especially from aerial photos that Isle Royale and the associated islands are "a series of long parallel ridges and valleys, which give it a washboard aspect" (Huber, 1983). These ridges and valleys trend northeast-southwest and parallel the trend of the islands and continue off the main island as island ridges sticking up above the water. These ridges and valleys also are asymmetric, in that the northwest-facing slopes are much steeper than the southeast-facing slopes. Drainage is poor on the island and the valleys between the ridges are occupied by swamps and bogs.

Geologic History

There are two major time lines at Isle Royale that are separated by over 850 million years: the formation of the bedrock in the Precambrian and glacial activity in the Pleistocene epoch. Keweenawan rocks, Middle Proterozoic in age, is a sequence applicable more to the Lake Superior region than elsewhere. Absolute ages are between 1,600 ma and 900 ma for the Middle Proterozoic. Events represented by Keweenawan rocks discussed below occurred mainly between 1,100 ma and 1,000 ma.

The Lake Superior Region of Northern Wisconsin, northeast Minnesota, and the Upper Peninsula of Michigan, including Isle Royale forms part of the Canadian Shield and is the largest surface exposure of Archean and Proterozoic rocks (2.6 to 1.6 billion years old) in the United States (Vigil, 2000). Archean rocks, which form the subsurface and therefore are not exposed at Isle Royale, generally consist of alternating belts of greenstone-granite and gneiss (LaBerge, 1994). These were formed from graywackes, granitic intrusions as well as lesser amounts of quartz sandstone and stromatolitic carbonates deposited during continental accretion. The Early Proterozoic in the Lake Superior region was a period of erosion followed by the breakup of the Archean supercontinent in smaller fragments, some of which reassembled forming the Penokean Mountains (LaBerge, 1994).

The Middle Proterozoic Keweenawan sequence (or supergroup) consists of the following (from oldest to youngest):

Bessemer Formation – Lower Keweenawan; basal sandstone and conglomerate; not exposed in Isle Royale

Volcanic sequence – Lower (?) and Middle Keweenawan; lava flows and pillow lavas; not exposed in Isle Royale

Intrusive Rocks – Middle (?) Keweenawan; mostly dikes and sills of gabbro; includes the Duluth Complex

Portage Lake Volcanics – Middle Keweenawan; upper sequence of volcanic rocks interbedded with sediments; extensively exposed on Isle Royale.

Copper Harbor Conglomerate – Middle Keweenawan; red to brown arkosic conglomerate and sandstone; extensively exposed on Isle Royale (Wolff and Huber, 1973).

The Portage Lake Volcanics represents roughly the upper half of a huge pile of lavas that erupted from a rift system that formed the long axis of an arc-shaped trough in what is now the center of Lake Superior. The rift probably extended from Kansas to the lower Michigan peninsula (Huber, 1983). As the lava continued to erupt, the rift began to subside, both from the accumulation of lava and from the removal of the lava supporting the extrusion (LaBerge, 1994). This subsidence continued after the extrusion of lava ceased and as the overlying Copper Harbor Conglomerate was being deposited.

The continued downwarping resulted in an inward flow pattern of streams and rivers carrying pebbles and cobbles. The result today is a bowl-shaped syncline, with the upturned beds cropping out on the Keweenaw Peninsula to the southeast (beds dipping northwest) and on Isle Royale to the northwest (dipping southeast). The rocks on Isle Royale dip from between 10° and 50° to the southeast, steeper on the north side. The Isle Royale fault pushed up the volcanics and conglomerates forming the elongate ridge that is the island (Huber, 1983). The Portage Lake Volcanics and the Copper Harbor Conglomerate have an obviously strike (trend) northeast-southwest paralleling the trend of the island. The interbedded sedimentary rocks are less resistant than the lavas and form valleys and the more resistant lavas form ridges. Jointing has resulted in crosscutting ravines and drainages (Huber, 1973).

Whatever deposition that took place above the Copper Harbor Conglomerate in the Late Proterozoic has since been eroded away leaving a gap of about 570 million years. In the Pleistocene Epoch, glacial advance and retreat modified the topography. Evidence indicates that glaciers overrode the island in all four glacial advances and each successive glaciation obliterated the previous one. The last advance was about 11,000 years ago. Ultimately the glaciers removed the softer sediments deepening the preglacial lowlands along the axis of Lake Superior, leaving behind the present Lake Superior basin with Isle Royale remaining a ridge of more resistant rock (Huber, 1983).

The glaciers had a profound effect on the topography of Isle Royale. Not only did they scour out the softer sedimentary rock leaving a valley-and-ridge topography, but also left many glacial features such as striations, drumlins, moraines, and deposits of till. Glacial advance and retreat directly and indirectly controlled paleo-shoreline position. As the glaciers retreated and melted, the lake levels rose from the addition of water, although retreating glaciers uncovered lower

outlets which had the effect of lowering lake level. However, upon glacial retreat, isostatic rebound from removal of the weight of the ice resulted in uplift and a relative lowering of water level. The result has been that there are several paleo-shorelines that have been correlated with certain paleo-lakes. From oldest to youngest in succession are: Lake Duluth, Beaver Bay, Lake Minong, Lake Houghton, Lake Nipissing and the present Lake Superior. The identification of these beach ridges is important in studying human habitation, since settlements occur along these shorelines (Huber, 1983).

Significant Geologic Resource Management Issues at Isle Royale National Park

1. Identify and study submerged geomorphology.

About two-thirds of the park is below lake level. Therefore, it is important to understand the bathymetry and geology of the submerged areas. There are critical fish habitats that need study. USGS maps extend to only 15 feet depth offshore. Many shoals and other fish habitats are not mapped. The method of choice is LIDAR, which is being used by the Natural Resources Conservation Service (NRCS) for terrestrial studies. LIDAR can measure through the leaf cover, but the best time for these studies would probably be after the leaves drop but before the first snow – probably September.

LIDAR for benthic studies use a different sensor than for soils. Two lasers are used, one infrared (IR) for the surface and one blue-green for the bottom. Cost is estimated to be about $44,000. The Army Corps of Engineers (ACE) in the ENG Shoals Program uses 2mX2m, the highest resolution, down to 150 feet. The cost for this resolution is estimated to be $630,000. For 4mX4m resolution, the cost is estimated at $225,000. The planning, mobilization, and demobilization alone would cost about $65,000. It may be more realistic to survey only the trout spawning areas rather than the whole coast.

2. Identify ancient shorelines.

Identifying and mapping ancient shorelines can not only provide the history of the relative rise and fall of the lake level in response to glaciation, but also pinpoint the location of settlements and human artifacts. Some of this mapping was done by Huber, but much more remains to be done. Huber mapped the paleo-shorelines of glacial Lake Minong and Nipissing, published in USGS Professional Paper 754-A, but only in the southwest part of the park. These areas have a high potential for having archeological sites. Furthermore, Huber apparently was not aware at the time of the “Marquette Advance.” Soils mapping by the NRCS could complement the surficial map by Huber. The NRCS is prepared to begin the process by late May 2005. John Anderton, Associate Professor of Geography at Northern Michigan University would like to accompany the soil survey either in Fall 2005 or the following year.

The oldest known archeological sites are about 4,000 to 5,000 years old. There could be older sites (8,000 to 9,000 years old) along some Minong shorelines. Some have been found at Thunder Bay, Ontario. These sites could be under water now. Stumps have been found at Grand Island at over 200 feet depth that are believed to be 8,000 years old.

3. Identify old mining sites

Historic mining, mainly for copper, occurred at three periods in time: 1840s-1850s, 1870s, and 1890s. There is also evidence that there was some prehistoric mining by Native Americans. Unlike the Keweenaw Peninsula and other areas of the Great Lakes, Isle Royale did not have abundant deposits of copper. Native copper is widely distributed but there are no large lode deposits (Huber, 1983). A survey of old mining sites was done in the late 1980s, mostly along trails and near campgrounds, but about 80% of the park is unsurveyed. There is also a need for bat surveys as well.

Two mines of note are the Island Mine and the Minong Mine, both of which were financial failures. The Island Mine is near the west end of Siskiwit Bay. Native copper occurs in the matrix of a conglomerate . At the Minong Mine copper occurs as nodules and irregular masses in fractures in altered rock. About 250 tons of copper was produced from the Minong Mine (Huber, 1983).

4. Water quality and supply

Currently, all drinking water comes from Lake Superior. It is expensive to pump, clean, and purify the water. There are some mineral springs that animals (e.g. moose) use, but most are too high in mineral content. The park would like to put down a water well, but the characteristics of the groundwater aquifer system are not well known. The water table is high and there may be some contamination from human wastes as well as from petroleum spills, especially at Rock Harbor, Mott Island, Amygdaloidal Island and Windigo. There may be residual PCBs, mercury, and other toxins in the surface and groundwater.

5. Other issues

> Species Isolation: When was the island isolated from the mainland? When Lake Superior freezes over, there is opportunity for some animals to migrate to the island. Once the ice thaws, the animals are isolated. Why are there plants native to the Pacific Northwest on the island? The island used to have caribou and lynx, but now there are more moose and wolves. Populations of some species periodically collapse.
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> State Gem: Isle Royale is known as the home of the state gem chlorastrolite, also known as “Isle Royale greenstone.” However, this is not greenstone in the petrologic since, but actually a variety of the mineral pumpellyite [$Ca_2MgAl_2(SiO_4)(Si_2O_7)(OH)_2 \cdot H_2O$]. The mineral was discovered on Isle Royale by C.T. Jackson and J.D. Whitney in 1847. It was later identified as pumpellyite from a similar mineral first described on the Keweenaw Peninsula in 1825 by Raphael Pumpelly (Huber, 1983). The chlorastrolite variety on Isle Royale has a characteristic mosaic or mottled pattern know as turtleback. Since this variety is thought to occur only on Isle Royale, any specimens found elsewhere probably were removed illegally from the island. As visitation to the island increases, specimen theft may become a problem.

Surface Water Issues: There has been no watershed mapping in ISRO. There is a need for stream profile data as well. Human waste disposal in shallow privies has the potential to contaminate both surface and groundwater. There have been petroleum spills as well as lead contamination (on Passage Island).There is a need to identify and map the near surface fracture system to help understand surface and groundwater flow regimes.

Wetlands: There has been monitoring of aquatic vegetation in wetlands and no major changes in wetland extent have been observed. No coring of wetlands has been done, even though this could provide a wealth of information on the sediment, climate, cultural, and fire history of the island. How will drawing groundwater affect the springs and wetlands?

Scoping Meeting Participants

Sid Covington	Geologist	NPS, Geologic Resources Division
Anne Poole	Geologist	NPS, Geologic Resources Division
Phyllis Green	Superintendent	NPS, Isle Royale National Park
Jean Battle	Chief, Natural Resources Mgt.	NPS, Isle Royale National Park
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On ferry:		
Liz Valencia	Chief, Cultural Resources Mgt.	NPS, Isle Royale National Park
Via conference call:		
Pete Biggam	Soil Scientist	NPS, Natural Res. Information Div.
Ulf Galvert	GIS Specialist	NPS, Great Lakes Network
Larry Carey	Soil Scientist	USDA, NRCS

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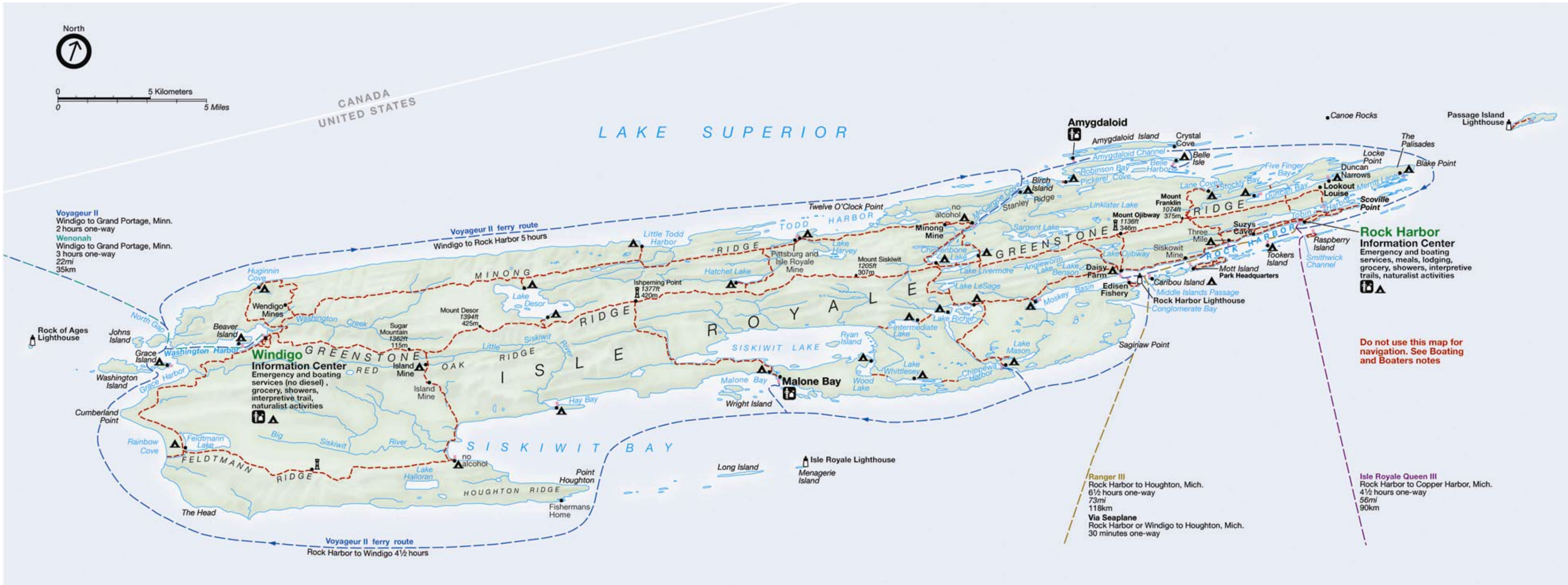

North
0 5 Kilometers
0 5 Miles
CANADA
UNITED STATES
LAKE SUPERIOR
Voyageur II
Windigo to Grand Portage, Minn.
2 hours one-way
Wenonah
Windigo to Grand Portage, Minn.
3 hours one-way
22mi
35km
Voyageur II ferry route
Windigo to Rock Harbor 5 hours
Rock of Ages Lighthouse
Johns Island
Grace Island
Washington Island
Washington Harbor
Grace Harbor
Cumberland Point
Rainbow Cove
Feldtmann Lake
FELDTMANN RIDGE
The Head
Beaver Island
Huginnin Cove
North Gap
Wendigo Mines
Washington Creek
Windigo
Information Center
Emergency and boating services (no diesel), grocery, showers, interpretive trail, naturalist activities
GREENSTONE
RED OAK RIDGE
Sugar Mountain 1362ft 415m
Island Mine
Mount Desor 1394ft 425m
Lake Desor
MINONG
RIDGE
Little Siskiwit River
Big Siskiwit River
Lake Halloran
no alcohol
HOUGHTON RIDGE
Point Houghton
Fishermans Home
SISKIWIT BAY
Hay Bay
ISLE ROYALE
Ishpeming Point 1377ft 420m
Little Todd Harbor
Hatchet Lake
TODD HARBOR
Twelve O'Clock Point
Pittsburg and Isle Royale Mine
Lake Harvey
Mount Siskiwit 1205ft 367m
SISKIWIT LAKE
Ryan Island
Malone Bay
Wright Island
Long Island
Isle Royale Lighthouse
Menagerie Island
Intermediate Lake
Lake Whittlesey
Wood Lake
Lake Richie
Chippewa Harbor
Lake Mason
Saginaw Point
Amygdaloid
Amygdaloid Island
Amygdaloid Channel
Crystal Cove
Belle Isle
Belle Harbor
Robinson Bay
Pickerel Cove
Birch Island
McCargoe Cove
Stanley Ridge
no alcohol
Minong Mine
Chickenbone Lake
Lake LeSage
Lake Livermore
Sargent Lake
Linklater Lake
Angleworm Lake
Lake Benson
Lake Ojibway
Mount Ojibway 1136ft 346m
Mount Franklin 1074ft 375m
Daisy Farm
Edisen Fishery
Moskey Basin
Siskowit Mine
Three Mile
Suzys Cave
Caribou Island
Mott Island Park Headquarters
Middle Islands Passage
Rock Harbor Lighthouse
Conglomerate Bay
Tookers Island
Raspberry Island
Smithwick Channel
ROCK HARBOR
Lane Cove
Stockly Bay
Five Finger Bay
Duncan Bay
Duncan Narrows
Locke Point
The Palisades
Blake Point
Lookout Louise
Merritt Lane
Tobin Harbor
Scoville Point
Canoe Rocks
Passage Island Lighthouse
Rock Harbor
Information Center
Emergency and boating services, meals, lodging, grocery, showers, interpretive trails, naturalist activities
Do not use this map for navigation. See Boating and Boaters notes
Ranger III
Rock Harbor to Houghton, Mich.
6½ hours one-way
73mi
118km
Via Seaplane
Rock Harbor or Windigo to Houghton, Mich.
30 minutes one-way
Isle Royale Queen III
Rock Harbor to Copper Harbor, Mich.
4½ hours one-way
56mi
90km
Voyageur II ferry route
Rock Harbor to Windigo 4½ hours

Isle Royale National Park boundary extends 4.5 miles from Isle Royale and the outer islands or to the international boundary.

Trail
Dock
Ranger station
Campsite
Lookout Tower
Lighthouse

Inland Lake Canoe Campgrounds
Intermediate Lake
Lake Richie Canoe
Lake Whittlesey
Wood Lake

Day Use Only Docks
Amygdaloid
Lookout Louise
Mott Island
Passage Island
Raspberry Island

Public Overnight Docks
Beaver Island
Belle Isle
Birch Island
Caribou Island
Chippewa Harbor
Daisy Farm
Duncan Bay
Duncan Narrows
Grace Island
Hay Bay
Malone Bay
McCargoe Cove
Merritt Lane
Moskey Basin
Rock Harbor
Siskiwit Bay
Three Mile
Todd Harbor
Tookers Island
Windigo