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THE MAINE GEOLOGIST
THE NEWSLETTER OF THE GEOLOGICAL SOCIETY OF MAINE

MARCH 1977

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Running out of gas and oil

This headline led off a front page article in the March 8, 1977 issue of the Brunswick TIMES RECORD, describing testimony to a U. S. Senate committee by President Carter's energy chief, Dr. James Schlesinger, concerning the country's need for energy conservation and planning. Schlesinger was quoted in the article as saying "We must realize that we are running out of oil and gas and we must do something about it". And, "In this area, there ain't no light at the end of the tunnel". Schlesinger is reported to have displayed a chart which showed oil and gas reserves running out in the early 21st century.

Four days before these government hearings, Tom Eastler of the University of Maine, Farmington, made a similar, if even less heartening, presentation to the Winter Meeting of the GSM at Colby. Based on his own research and analyses of publicly-available data from both governmental and oil company reports, Tom has concluded that at the maximum level of optimistic projections, the United States will run dry of domestic petroleum reserves (including the Alaskan North Slope oil) by 1997, twenty years hence. It is in the early 21st century that all oil in the rest of the world will be gone, no matter who owns it, if world consumption continues at the current rate. Projections are essentially similar for natural gas.

The United States has, by paper calculations, very large reserves of coal, estimated at some 1.5 trillion tons, or 67 billion billion BTU's of energy equivalent. The Federal Energy Administration has calculated that this will last us some 2300 years. Tom Eastler rejects "reserves" deeper than 1000' below surface and those held in seams less than 28 inches thick, and applies a 50% mining recovery factor to what's left, to calculate a 60-year life for domestic coal if it is used for all of our energy needs at our current rate of energy consumption. The technology has not yet been proven for recovering gas directly from in situ coal seams. And you can't run B-1 bombers on coal.

Alternative sources of energy include that to be derived from the sun, winds, geothermal gradients, nuclear fission and fusion, and from organic materials such as methanol, grain and garbage. In general, Toms sees these as inadequate or impossible short-term alternatives to oil and gas because of various limitations in proven technology, available capital or environmental safety. He feels that hydrogen electrolyzed from water may at some future time become a major, plentiful energy resource. The problem here, however, is that no research is currently being conducted to develop effective ways to produce, distribute and use hydrogen on a large scale. In fact, there are no short-term energy alternatives to oil and gas, and little is being done even to develop long-term alternatives.

Tom's conclusions: there is a serious, world-wide energy problem involving both civilian and military activities; solutions may be possible through a concerted effort launched immediately at great personal sacrifice; with the given time constraints, technological supremacy of the United States does not guarantee effective solutions; local, state and national political leaders must be informed of the grievous nature of the problem; action, not lip service, is needed from the political leaders; and at home, we must each begin immediately to prepare ourselves for a future without oil and gas.

Tom paints a grim picture which the facts seem reasonably to support. Production of petroleum from U. S. wells peaked in 1970, and has been decreasing since that time. Domestic production of gas, similarly, peaked in 1972, and has been going down since. For the past two decades the discovery rate for new oil reserves has consistently been decreasing per foot of exploration drilling, while our consumption of oil has been increasing exponentially. The calories of energy consumed to create one calory of food have also been increasing very rapidly. Most of our fertilizer is now made from natural gas. It is axiomatic that an exponentially-increasing consumption mode based on a finite resource base must collapse.

The years before collapse of the good old American way of life can now be counted on your fingers, if the country blindly persists in exponential growth based on petroleum energy. Tom sees the oil furnace in his cellar flickering out within 10 years. The need for strict conservation of petroleum resources, for lubricants and military requirements, must become of paramount national priority well before the domestic reserves are exhausted. In this respect, if oil is ultimately found beneath George's Bank, it

energy (cont.)

should be conserved for future vital needs, not pumped for burning at 70 MPH on the Interstate highways of America.

There is something about geologists which seems commonly to lead us in directions other than to the stage of human affairs. Most of the time we seem to prefer to talk to each other. This trait has historically been fairly understandable, possibly, because the public could hardly be expected to get very tore up over the sequences and styles of deformations in metamorphic rocks, or even over the fabric of till in its own back yard. Now, however, we have something of vast importance to tell the public, that our primary source of energy is running out, increasingly so with each passing day. The very foundation of our gluttonous life style is now eroding, rapidly, and will collapse like the Teton Dam if we don't start now to modify it.

Tom is working hard to get the word out. His thesis was presented in a story in the February (1977) issue of YANKEE magazine. He has talked to service and social organizations in Maine and elsewhere. He is working now to have an article published in the READER'S DIGEST. Since geologists as a class comprise only something like one one-hundredth of one percent of the general population, our chorus may at first sound feeble. But it would seem that we have a professional responsibility to advise our friends, neighbors, and political representatives at all levels that our country must start now scrupulously to conserve our present energy resources, and rapidly to research, prove and develop such alternative future energy resources as may be possible and suitable for maintaining some reasonable life style for the entire population. (JRR)

Proposed Summer Meeting

The Summer Meeting, which is also the Annual Meeting of the Society, has normally been a one-day affair held on a Friday, some time around August 1st. The program has generally been comprised of displays and discussions by members of the Maine Survey and others on the status and findings of geologic projects in Maine, followed by a short business meeting to report on finances and other secular matters, and to elect officers for the ensuing year.

At this reading, this year's Summer Meeting is tentatively proposed to take the form of a field trip, on some portion of the weekend of either July 30th or August 6th. We'd have an overnight stay at, for example, a facility of the University of Maine, where we might unroll our sleeping bags at some charge comfortably below the going commercial rates for summer tourists. The Annual Meeting and any technical discussions would be held in the evening; the field trip would consume the day. It may be that we could rent a bus, to convey all participants in the most compact, informative and energy-efficient manner possible.

Bill Rideout and Brad Hall are looking into the planning for this proposed program. If you have any ideas on the location or subject for an interesting field trip, and/or wish to volunteer your services as a trip leader, please contact Bill or Brad at your earliest opportunity.

GSM Publications Proposal

It was reported in the December 1976 Newsletter that a Committee on Publications was considering a publications policy for the Society. At the Winter Meeting on March 4th at Colby, a proposal developed by Art Hussey was presented for consideration. Art's proposal is to publish a formal Bulletin series, "Shorter Contributions to Maine Geology", in a soft-cover format comprising some 60-80 pages, photo-offset printing of clean, typed manuscripts. Articles may include blackline maps and diagrams, plus a reasonable number of black-and-white photographs.

The procedure for the first publication (if formally approved by the Society) will be for prospective authors to prepare a draft manuscript for submission to reviewers. After review, the manuscript will be returned to the author for that person to put into final, camera-ready typewritten form for publication. Art Hussey has volunteered to act as Engineer-Publisher-Editor for Bulletin No. 1. All geologic subjects pertaining to Maine will be welcome.

Art's proposal suggested an 8" x 10½" booklet size, with a 6½" x 9" double-column text size on the page. Manuscript pages might be typed somewhat oversize and reduced photographically for offset to result in a clean, compact final product. (For example, this Newsletter is an IBM Standard type, reduced to 72% of original size.) Maps and diagrams may be drafted at any reasonable size, so long as they will reduce legibly to the final page size or smaller.

The cost of printing the Bulletin, and the procedure for financing it, have not yet been finally determined. Art has an estimate from a local printer of about $730 for 300 copies, or about $1025 for 500 copies, produced in the size described above. Archie Berry has a rough estimate of around $200 for 300 copies from the University Press at Farmington. The University cannot, however, do reducing, and will print on a standard 8½" x 11" page. We are continuing to look into other printers, to see what they can offer us at what price.

If the Society gets into the business of publishing (and selling) technical material, it appears that we will have to incorporate and establish ourselves formally as a non-profit, educational organization. If we have read the signs correctly, this status will permit us to handle something like $5000 per year without incurring the untoward interest of the Andover Computer.

As plans for the proposed Bulletin develop some hard facts, we will put them into some formal shape and distribute the details for the Society members to consider and vote on. In the meantime, we will greatly appreciate suggestions, ideas or any other general thoughts or assistance any members may wish to offer.

Historical Earthquakes in Maine

By J. R. Rand

In connection with seismic-safety investigations conducted over the past decade for several proposed nuclear power plant sites in New England, Weston Geophysical Research, Inc., Westborough, Massachusetts, has researched the epicentral locations of the approximately 100 earthquakes which have occurred historically within the State of Maine. Of these events, 58 were of Modified Mercalli Intensity III-IV to VI, and are plotted on Figure 1 (Page 5), and detailed in Table I (Page 4). The remaining 40-odd events, not plotted here, were all very small - Intensity III(MM) or less, and were felt only very locally or were not felt except by instruments. The Modified Mercalli Intensity Scale of 1931 is described on Page 6.

Of these unplotted microseismic events, some 45% occurred in a northwest-trending cluster in central Maine between Winterport-Orrington and Greenville-Katahdin Ironworks; about 23% occurred in a zone in western Maine between Casco Bay and Rangeley; about 8% occurred in coastal Washington County; and the remainder were widely scattered in northern Maine and in offshore areas.

The data for all epicenters which lie to the west of 68.5° west longitude on Figure 1 and in Table I were made public by their submittal to the U. S. Nuclear Regulatory Commission by Boston Edison Company in December, 1976, in connection with studies for a proposed nuclear power plant in Plymouth, Massachusetts (Boston Edison, 1976a, 1976b). The remaining data, for the 13 events defined in Washington County and the 2 events in Aroostook County, have very generously been made available for this paper by Weston Geophysical Research from its private files (Weston, 1976).

GENERAL LOCATION CONSIDERATIONS

An earthquake is the vibratory motion of the earth produced by the sudden release of stress which has concentrated through time on some kind of geologic structure at depth. New England earthquakes are generated from small fault movements which occur within the crust at relatively shallow depths. The location of fault-movement strain at depth is termed the earthquake's hypocenter or focus. The point on the earth's surface directly above the focus is the epicenter.

With a sufficiently closely-spaced array of instruments to detect and record the arrival times and physical characteristics of the elastic waves which radiate from a source of earthquake strain, and with an exact understanding of the velocity variations which occur as those waves are transmitted to a given instrument through different layers of the earth's crust, an earthquake's focus and epicenter can be calculated quite accurately. It is also possible to calculate the orientation of the fault movement at depth (the focal plane) which released the earthquake waves.

Unfortunately, most of Maine's historical earthquakes occurred before modern detection instruments (seismometers) were developed. The remainder of the earthquakes, generated within the past 40-odd years since the establishment of a regional seismic network, occurred during the period when seismometers in or near Maine were too widely separated (at East Machias, Caribou, Milo, Berlin, New Hampshire, and Weston and Harvard, Massachusetts) to permit really accurate hypocentral locations for these more recent events to be calculated.

A number of new seismometer installations are now in operation or scheduled for placement shortly, at Allagash, Mt. Katahdin, Houlton, Jackman Station, Princeton, Bucksport, Hinckley, Turner, and North Windham (Maine Geologist, 1976). Upon completion of these new installations, the Maine seismic network will consist of a twelve-station array which will transmit raw data to Weston Observatory, Weston, Massachusetts. These stations will be located approximately on an 80-kilometer (50-mile) grid, designed to permit the detection of Magnitude 2.3 (and greater) events by at least 2 stations, and to enable the calculation of epicentral locations within an accuracy of 2 to 3 kilometers (1 to 2 miles).

MAINE EPICENTRAL PLOTS

It is quite important constantly to keep in mind the fact that there is a certain inherent lack of precision in the specific locations given for Maine earthquake epicenters. All events recorded to date in Maine have been relatively small earthquakes, resulting in somewhat diffuse zones of perception by people and instruments. No surface faulting has been reported in association with Maine earthquakes, to assist in defining exact epicentral locations.

Epicenters for events recorded instrumentally (shown by solid triangles on Figure 1) were determined by triangulation from distant seismic stations, and may be inaccurate by as much as 5-15 kilometers (3-10 miles). Locations for non-instrumentally recorded events (open triangles on Figure 1) were estimated by study of the distributions of the places where the greatest effects (Intensities) were felt by people or structures, and may be inaccurate by as much as 10-25 kilometers (6-15 miles). The locations of the oldest events may be appreciably biased because of discontinuities in human population distributions.

SEISMICITY-TO-GEOLOGY RELATIONSHIPS

Considering the possible inaccuracies in the individual epicentral locations, therefore, it is probably not technically correct to assign any single epicenter to any discrete geologic structure mapped in the bedrock at the ground-surface epicentral "location". It does seem reasonable, however, to correlate certain clusters of epicenters with geologic structural features which have sub-regional dimensions.

1. Ten epicenters of historically-reported earthquakes, including one Intensity VI(MM) event, lie in a distinct cluster in close spatial association with the north northwest-trending Oak Bay fault in Passamaquoddy Bay, eastern Maine. No instrumental events occur in this cluster.

2. Twelve epicenters, with one Intensity VI(MM) event, occur in central Maine near Orrington on the south and Blanchard-Milo on the north. These two clusters lie within a 35 x 105-kilometer (20 x 65-mile) northwest-trending zone distinctly filled in, between Orrington and Greenville-Katahdin Ironworks, by numerous microseismic events (Weston, 1976). The seismic clustering coincides spatially with a marked physiographic break (USDA, 1974); with a trend of old lead-silver mining prospects (Rand, 1958); with a strong pattern of N36°W stream courses; and with an apparent trend, in Penobscot County, of high-yield bedrock water wells (Caswell, 1976).

3. Numerous epicenters, with four Intensity VI events, occur in southwestern and western Maine. Many trend along northeast-striking bedrock foldbelts from Biddeford to Waterville, where gravity and metamorphic patterns, supplemented locally by detailed bedrock mapping (Hussey and Pankiwskyj, 1976) infer the presence of major northeast faults. The remaining events in this region are scattered in a south-trending zone between Rangeley and Lewiston, where bedrock folds also turn to a southerly strike (Moench and Zartman, 1976). Three of the four largest events, plus recent microseismic activity (Chiburis and Ahner, 1976), plot where the two foldbelts converge, in the Litchfield-Lewiston-Norway area. This anomalous area also contains two discordant, post-metamorphic intrusives, of which one contains gabbroic rock. In any given crustal stress field, anomalous stress might be expected to accumulate near the contact of a mafic plug and its enclosing felsic country rock domain (Boston Edison, 1976b; Kane, 1977).

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TABLE I MAINE HISTORICAL EARTHQUAKES INTENSITY IV(MM) AND GREATER

Data Source: Weston Geophysical Research, Inc. (1976)

	Coordinates N.Lat.	Coordinates W.Long.	Felt Area Sq.Km.	Epicentral Region
INTENSITY VI(MM)				
Dec. 23, 1857	44.1	70.2	10,000	Lewiston
Mar. 21, 1904	45.0	67.2	393,000	Pembroke
Jul. 15, 1905	44.2	70.0	100,300	W.Central Maine
Aug. 21, 1918	44.2	70.5	8,800	Norway
Feb. 08, 1928	45.3	69.0	1,600	Milo
Apr. 26, 1957	43.6	69.8	82,500	Casco Bay
Jun. 15, 1973	45.4	71.0	200,000	Woburn, Quebec
INTENSITY V(MM)				
Jun. 26, 1808	Coastal Maine		-	Bucksport-Saco
Nov. 28, 1814	43.7	70.3	49,000	Westbrook
May. 05, 1821	44.8	68.8	20,700	Bangor
Jun. 10, 1823	44.8	68.8	-	Bangor
Jan. 16, 1855	44.0	71.0	33,000	Fryeburg
Feb. 27, 1874	45.2	67.3	3,000	Calais
Dec. 31, 1882	45.0	67.0	40,000	Pass'quoddy Bay
Mar. 22, 1896	45.2	67.2	13,000	St.Stephen, N.B.
Sep. 25, 1897	45 -	68 -	18,000	Washington Co.
Sep. 25, 1897	44.7	68.7	47,000	Bangor
Aug. 30, 1905	43.1	70.7	3,600	Kittery
Aug. 22, 1938	44.7	68.8	13,000	Orrington
Jan. 14, 1943	45.3	69.6	131,000	Blanchard
Dec. 28, 1947	45.2	69.2	15,200	Dover-Foxcroft
Oct. 05, 1949	44.8	70.5	45,200	Byron-Madrid
Sep. 19, 1958	43.6	70.2	Local	Cape Elizabeth
Jul. 24, 1966	44.5	67.6	Local	Jonesport
INTENSITY IV(MM)				
Dec. 13, 1766	43.1	70.8	-	Kittery
May. 06, 1807	43.5	70.5	-	Biddeford
Aug. 27, 1829	44.2	69.8	-	Gardiner
Jan. 30, 1850	45.1	67.1	-	St.Andrews, N.B.
Feb. 19, 1855	44.5	69.6	-	Waterville
Dec. 08, 1857	46.7	68.0	-	Maple Grove
Feb. 08, 1870	44.1	69.8	-	Richmond
Jan. 20, 1881	44.0	70.0	-	Lisbon Falls
Feb. 01, 1888	44.5	70.5	-	Dixfield
Aug. 14, 1888	44.3	70.0	-	Winthrop
Oct. 05, 1899	44.0	69.5	-	SE Lincoln Co.
Oct. 19, 1906	43.5	70.5	-	Biddeford
Jan. 23, 1910	43.8	70.4	-	Windham
Oct. 20, 1910	44.4	68.8	-	Castine
Dec. 11, 1912	45 -	68 -	85,600	Eastern Maine(?)
Jan. 13, 1914	45.2	67.3	-	Calais
Feb. 22, 1914	45.0	70.5	-	Rangeley
Jul. 11, 1919	43.9	70.0	-	Brunswick
Oct. 10, 1921	44.9	67.0	-	Eastport
Aug. 28, 1926	44.8	70.4	-	Phillips
Nov. 24, 1926	45.0	67.1	-	Perry
Jan. 27, 1928	45.3	69.0	-	Milo
Mar. 22, 1928	45.3	69.0	-	Milo
Mar. 28, 1928	45.3	69.0	-	Milo
Nov. 20, 1928	45.0	67.2	-	Pembroke
Feb. 05, 1929	44.0	70.3	-	South Poland
Aug. 02, 1934	43.7	70.3	-	Falmouth
Aug. 03, 1934	43.7	70.3	-	Falmouth
Mar. 08, 1942	44.1	70.2	-	Lewiston
Jul. 15, 1945	44.9	67.0	-	Eastport
Jan. 06, 1948	45.2	69.2	-	Dover-Foxcroft
Nov. 29, 1948	45.2	69.2	-	Dover-Foxcroft
Apr. 28, 1967	46.3	67.9	-	Monticello
Jul. 01, 1967	44.4	69.9	-	Readfield

INSTRUMENTALLY-RECORDED EVENTS, III-IV(MM) AND LARGER

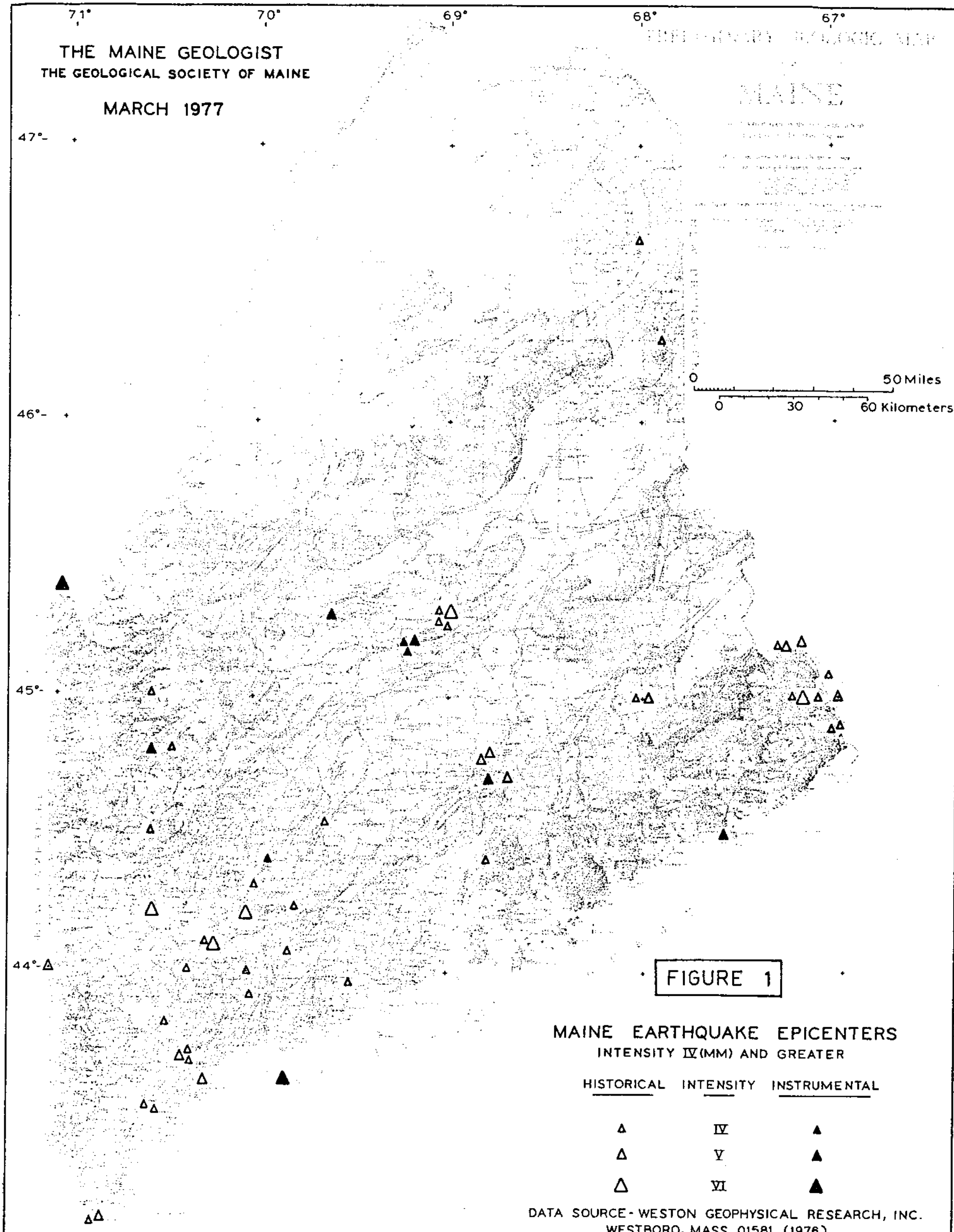
	Epicentral Region	Intensity (MM)	Spectral mbLg Magnitude
Jun. 15, 1973	Woburn, Que.	VI	5.0
Apr. 26, 1957	Casco Bay	VI	4.8
Oct. 05, 1949	Byron-Madrid	V	4.5
Jan. 14, 1943	Blanchard	V	4.4
Dec. 28, 1947	Dover-Foxcroft	V	4.4
Aug. 22, 1938	Orrington	V	4.0
Jul. 01, 1967	Readfield	3 IV's	up to 3.7

NOTES

1. Dates prior to 1900 are in Local time; dates from 1900 to present are in Greenwich Mean Time.

2. Intensity assignments are according to the Modified Mercalli (MM) Scale of 1931; events which overlap grades are assigned the higher grade (III-IV = IV, etc.)

3. Latitude-Longitude coordinates are rounded to the nearest tenth of a degree; the inherent inaccuracy of epicentral locations may be greater than one-tenth of a degree.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MARCH 1977
71°
70°
69°
68°
67°
47°
46°
45°
44°
0
50 Miles
0
30
60 Kilometers
FIGURE 1
MAINE EARTHQUAKE EPICENTERS
INTENSITY IV (MM) AND GREATER
HISTORICAL
INTENSITY
INSTRUMENTAL
IV
V
VI
DATA SOURCE - WESTON GEOPHYSICAL RESEARCH, INC.
WESTBORO, MASS. 01581 (1976)

MODIFIED MERCALLI EARTHQUAKE INTENSITY SCALE

(after Harry O. Wood and Frank Neumann, 1931 - adapted from Sieberg's Mercalli-Cancani scale, modified and condensed)

INTENSITY, scaled in Roman numerals, is a measure of an earthquake's effect on people and structures. Intensity depends not only on the size of an earthquake, but also on foundation conditions of structures and their design and quality of construction. Intensity is different than Magnitude, the mathematical measure of earthquake strain energy released.

I	NOT FELT, or not felt except rarely, under especially favorable circumstances. Sometimes dizziness or nausea is experienced at and outside of the edge of an area in which a great shock is felt. Sometimes birds and animals seem uneasy or disturbed. Sometimes trees, structures, liquids and bodies of water may sway. Doors may swing, very slowly.
II	FELT INDOORS BY FEW, especially on the upper floors, or by sensitive or nervous persons. As in Intensity I, but often more noticeably, dizziness or nausea may be experienced by some. Birds and animals may appear uneasy or disturbed; trees, structures, liquids, water bodies may sway. Doors may swing, very slowly. Sometimes hanging objects may swing.
III	FELT INDOORS BY SEVERAL, the motion is usually a rapid vibration whose duration in some cases may be estimated. The vibration is like that caused by a passing light truck, or by a heavy truck some distance away. Movements may be appreciable on upper levels of tall structures. Standing automobiles rock slightly. Hanging objects may sway slightly.
IV	FELT INDOORS BY MANY, outdoors by few; a few are awakened; very few are frightened. Vibration like passing heavy truck or heavy object falling. Dishes, doors, windows rattle; glassware clinks; walls and building frames creak; liquids in open vessels are disturbed slightly. Standing automobiles rock noticeably. Hanging objects frequently swing.
V	FELT INDOORS BY PRACTICALLY ALL; outdoors by many or most. Awakens many, frightens few; a few run outdoors; slight excitement. Direction of wave travel estimated, outdoors. Some dishes, glassware broken; some windows cracked; small objects overturned; pendulum clocks stopped; furniture moved slightly. Hanging objects, doors swing generally or considerably.
VI	FELT BY ALL, INDOORS AND OUTDOORS. Awakens all, frightens many; general excitement, some alarm; many run outdoors. Trees, bushes shake slightly-moderately. Small bells ring; some plaster cracked, falls; dishes, glassware broken, some windows; knick-knacks, books and pictures fall; furniture moved, many overturned. DAMAGE slight in poorly-built buildings.
VII	ALL FRIGHTENED, run outdoors; difficult to stand; general alarm. Noticed by people driving automobiles. Trees, bushes shake moderately-strongly; waves on ponds, water turbid; some sand banks cave. Large bells ring; chimneys, some walls cracked; weak chimneys, cornices fall; large plaster falls; numerous windows, some furniture broken; heavy furniture overturned. DAMAGE negligible in buildings of good design and construction; slight-moderate in well-built ordinary buildings; considerable in poorly-built structures, spires, old walls.
VIII	FRIGHT IS GENERAL, alarm approaches panic. Persons driving automobiles are disturbed. Trees shake strongly, branches break; some sand and mud ejected; springs, wells change flow. Very heavy furniture moved, overturned. DAMAGE slight in specially-built structures; considerable in ordinary buildings, partial collapse; walls, chimneys, columns, stacks and towers fall.
IX	PANIC IS GENERAL. Ground conspicuously cracked. DAMAGE considerable in masonry structures built especially to withstand earthquakes, and specially-built wood-frame houses are thrown out of plumb; damage is great in substantial buildings, some collapse; frame buildings may shift off foundations. Damage serious to reservoirs; underground pipes sometimes broken.
X	CRACKED GROUND, especially when loose and wet; fissures open along stream banks and canals. Considerable landsliding; changed water levels in wells. DAMAGE is serious to dams, dikes, embankments; severe to well-built wooden structures, bridges, some destroyed; most masonry and frame structures destroyed. Pipelines rent; open cracks, folds in highway pavements.
XI	DAMAGE GREAT. Many, widespread ground disturbances; broad fissures; landslides, earth slumps. Water ejected, charged with sand-mud; tsunami ("tidal waves") of significant magnitude. DAMAGE severe to wood-frame structures; most masonry structures collapse. Damage great to dams, dikes, bridges, rail lines; bridge piers fail; buried pipelines put out of service.
XII	DAMAGE TOTAL, practically all works of construction damaged greatly or destroyed. Disturbances in ground great and varied; numerous shearing cracks; numerous landslides, rock falls, failed bankings; large rock masses wrenched loose; fault slips in firm rock; water channels modified, deflected. Waves seen on ground surface. Objects thrown upward into the air.

ENGINEERING GEOLOGY

During the evening session of the Winter GSM meeting at Colby, Stanley Walker, Fred Bragdon and Earl Hill of Jordan Gorrill Associates, Bangor, described the sort of geological features which engineering geologists look for and evaluate in connection with feasibility studies and engineering design for foundations of buildings, dams, pipelines and other structures in Maine.

Stanley first described historical aspects of the development of foundation engineering from an empirical, trial-and-error procedure to one in which analytical or scientific methods are used to define earth or rock foundation properties. Foundation design is an ancient art, as the pyramids of Egypt bear expert witness. The art was not always wholly precise: something was missing in the foundation design for that famous tower in Pisa, Italy.

The empirical basis for foundation design was not materially improved until a few decades ago, when Prof. Carl Terzaghi developed analytical bases for testing soils characteristics, and created the discipline of "soils mechanics". The new analytical approach to foundation evaluation then required the development of exploration techniques to recover meaningful samples of soils for controlled testing and derivation of significant physical and mechanical properties.

While the application of soils mechanics principles to foundation engineering was a fundamental advance, occasional structures still had problems. The soils engineering profession then started to realize that geologic factors such as groundwater migration and variability of lithic or surficial units also influenced foundation integrity, and geologists began to join the staffs of engineering firms.

After describing many of the techniques and tools of soils testing, Stanley presented some examples of by-product evidence his investigations have turned up of particular interest to geologists. For example, the top surface of a delta on the East Branch of the Penobscot River at Millinocket stands at elevation 380', and (apparently) marine clays in East Millinocket rise to 310' to 320' elevations. A low sea-level stand is suggested beneath the Kennebec River at Bath, where wood specimens have been recovered from borings near the Carleton Bridge to elevation -75', in sandy sediments which overlie marine clay. In borings taken 4000' downstream from the bridge, desiccated (mottled) clay was encountered at -69' to -74' elevations.

In the watershed of the Stroudwater River in Gorham, borings drilled into a sand layer buried beneath more than 110' of clay have continuously overflowed with water derived from the sand layer. Consolidation tests of the clays overlying the sand aquifer indicate that the aquifer has been under high hydraulic pressure since the time of deposition of the overlying clay. Although this aquifer might at first glance seem like a useful groundwater source, the consolidation tests also indicate that if this aquifer should be drawn down, the pore pressure in the overlying clay will also be reduced, and the clay will settle. If the aquifer were to be pumped sufficiently to reduce the hydraulic pressure to the level of the underlying sand horizon, as much as 20' of settlement would occur in the overlying clay. The probability of damage to surface structures under such conditions is obvious. The potential for surface subsidence should always be evaluated in planning production from buried granular aquifers.

Fred Bragdon and Earl Hill presented slides of a series of grain-size distribution curves for 34 different basal tills which they have studied in Maine. Most of their curves showed a slightly non-uniform distribution of grain sizes, with curves generally slightly convex upward for much of the State where the bedrock is characterized by crystalline metamorphic and plutonic rocks. In Aroostook County, and in the Calais-Machias-Lubec area, the grain-size curves show convex-downward slopes. Brown ablation tills showed consistently coarser grain sizes than the underlying gray lodgment tills. No petrographic analyses had been made to explain the reasons for variations in grain-size distributions from area to area in Maine, since this information is not considered significant for purposes of effective foundation design.

Interim Membership Report

On March 4th, the Society had 68 paid-up members and a balance of $672.29. There were in addition 29 old members who had not yet paid dues for this current Society year 1976-77, plus around 16 former members who remain unpaid for the two years of 1975-76 and 1976-77. As a gentle reminder to the unpaid members, their address sticker on this Newsletter is coded YELLOW if they still owe for 1976-77. The code is RED if they still owe for 1975-76 and 1976-77.

The subject of dues payments becomes of some special interest in connection with making plans for publishing a formal "Shorter Contributions" Bulletin. Some money, possibly around $150, will be needed to pay for the Society's legal incorporation. If we publish through the University press at Farmington, we MAY wish to consider the giving of one free copy of the Bulletin to each paid-up member, and to finance the printing directly from Society funds, with recoupment to come passively from outside sales. If we opt for a higher cost (but possibly more "professional" looking) commercial job, then we may have to ask the members individually to underwrite the publication in advance, and await reimbursement from such sales as we can promote outside the Society.

The method and means for publishing is directly dependent upon the membership's wishes, but in any case we will need a substantial number of both interested and paid-up members to go to press.

THANKS AGAIN

The Winter Meeting of the Society was convened, under the kind auspices of Donaldson Koons, on March 4th at the Colby College geology department, with about 50 members and guests attending. We all wish to thank Don for his hospitalities.

The Geological Society of Maine
c/o John R. Rand, Cundy's Harbor
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THE MAINE GEOLOGIST is published four times a year, more-or-less, in September, late Fall, late Winter and maybe June or July, for Members of the Geological Society of Maine, a non-profit, non-incorporated educational society interested in all aspects of the geology of the State of Maine.

Correspondence about this Newsletter, or about membership in the Society may be addressed to John R. Rand, Cundy's Harbor, RD2-Box 210A, Brunswick 04011.

ADDRESS CORRECTION REQUESTED

Maine Survey Notes

Brad Caswell has completed a series of water resource maps for Penobscot County, under the State Planning Office's Coastal Planning Program. The maps, measuring 36" by 42", Scale 1:125,000, variously define overburden thickness, bedrock topography, yield of bedrock wells and total depth of bedrock wells for that county. You can buy blueline prints of each of these maps at the office of the Maine Survey, Augusta, at modest cost.

Also under State Planning Office funding, Brad has now completed a set of "Maine Coastal Zone Water Supply and Demand" maps, with an accompanying 400-page report, which define, town-by-town along the coast, the water supply systems, water demand and problems associated with groundwater resources. The maps and report are primarily designed for local and State planners, to define municipal supplies, areas of potential housing and industrial growth, aquifer areas, dumps, areas of poor soils, locations of gravel and bedrock wells, and quality of groundwater.

According to Brad, about 57% of the coastal towns will encounter some water supply problems in the next 10 years, primarily due to quality deterioration from high iron contents or human pollution. About 45% of the towns have a quality problem now, largely due to human pollution, which will require treatment plants within the next 10 years to correct. These plants will be new consumers of increasingly limited energy resources, and for the smaller towns will involve capital investments beyond the capability of the local population to pay.

The Boothbay area now has water quantity, quality and pollution problems, and it appears that Boothbay will have to go to some inland source for a suitable future supply. Coastal Washington County has local problems with high iron contents of the bedrock groundwater. The degree to which constant applications of agricultural chemicals may degrade the quality of their large, untapped gravel aquifers remains to be determined.

Barry Timson has just completed his report for the State Planning Office on the coastline inventory of shore erosion. This work includes 29 maps, Scale 1:48,000, defining 9 different categories of erosional rates due to wave action, mass wasting, etc. His report is written primarily for use by planners and laymen. The maps are currently available only as open-file materials which may be copied at the Maine Survey office.

Bob Doyle has announced that the Maine Geological Survey plans two bedrock fracture studies this summer under Nuclear Regulatory Commission funding through Pat Barosh. Gary Boone will run one of these, in northwestern Maine. Art Hussey will direct the other, in the area of relatively anomalous seismicity between Casco Bay and the Lewiston-Augusta area. Bedrock mapping is also planned between Danforth and Lubec, and possibly at points in central Maine and Aroostook County.