Cold Regions Engineering Workshop: 50th Anniversary of the First International Conference on Permafrost (1963-2013)

An Event Associated with the
C. W. Lovell Distinguished Lecture Series

INTERNATIONAL CONFERENCE ON PERMAFROST
1963
WEST LAFAYETTE INDIANA

PURDUE
UNIVERSITY

Bowen Laboratory, Room 1003
November 15, 2013

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INTERNATIONAL CONFERENCE ON

PERMAFROST

PURDUE UNIVERSITY NOVEMBER 11, 12, 13, 14, 15, 1963

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Organization: The International Conference on Permafrost was organized by a Planning Committee appointed by the Building Research Advisory Board. The names of members of the Planning Committee and of the Public Relations Committee for the Conference appear below.

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and
Dr. Jerry Brown, Past President (2003-2008), International Permafrost Association

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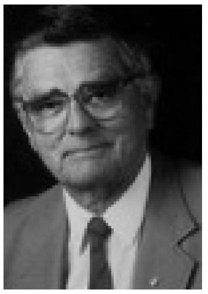
Noon:	Informal lunch for guests, faculty, and students
Session 1:	
1:00pm	Introductions and tribute to Bill Lovell Speakers: Professors Rao Govindaraju and Rodrigo Salgado, and Jerry Brown
1:30pm	Permafrost and the "Long" Thermopile Speaker: Ed Yarmak (Arctic Foundations)
2:10pm	The Trans Alaska Pipeline System Speaker: Thomas Krzewinski (Golder Associates)
2:40pm	Coffee Break
Session 2:	
3:00pm	Frozen in time: Permafrost and engineering problems Speaker: Frederick E. Nelson (University of Wisconsin-Milwaukee)
3:30pm	Lakes and wetlands in arctic environments Speaker: Laura Bowling (Purdue University)
4:00pm	Electrical Resistivity Tomography as a tool for geotechnical investigations in discontinuous permafrost Speaker: Antoni G. Lewkowicz (Ottawa University)
4:20pm	Coffee Break
Session 3:	
4:40pm	Coastal processes and engineering Speaker: H.J. Walker (Louisiana State University)
5:00pm	Modeling permafrost dynamics and their effects on carbon cycling in northern high latitude Speaker: Qianlai Zhuang (Purdue University)
5:30pm	Solid waste management in Alaska and the rising permafrost concern for future operations Speaker: Zach A. Umperovitch (Purdue University)
5:45pm	Discussion
7:00pm	No-host dinner at the Lafayette Country Club



C. W. LOVELL DISTINGUISHED LECTURE

https://engineering.purdue.edu/CE/Academics/Groups/Geotechnical/Details/seminar/Lovell

Professor Emeritus C. W. "Bill" Lovell was a native of Louisville, Kentucky, and received his BCE from the University of Louisville. He served in the U.S. Navy Construction Battalions (SeaBees) during World War II, and taught at the University of Louisville after the War. In 1948, he came to Purdue University he remained in this employment, receiving MSCE and Ph.D. degrees in the process. His service in Civil Engineering extended over 47 years, including major professorship for 60 theses and authorship for almost 200 papers. His research interests were broad and varied including soft rocks (shales), compaction and compacted properties, soil fabric and pore size distribution, slope stability and erosion, cold regions, pavements, and uses of waste materials in geotechnical engineering. In 1994, Bill became a facilitator/coach in Human Resources Services at Purdue. He specialized in delivering a variety of FranklinCovey leadership/personal development seminars, and received a "Facilitator of the Year" award from FranklinCovey. Bill was active in many community volunteer organizations, and continued to be an avid fly fisherman.

Sadly, Bill Lovell passed away Saturday, June 15, 2013 at the age of 90.

1963 Conference Resolutions

WHEREAS the first International Conference on Permafrost has assembled scientists and engineers from Argentina, Austria, Canada, Great Britain, Japan, Norway, Poland, Sweden, Switzerland, United States of America, Union of Soviet Socialist Republics and West Germany for discussion of more than 100 papers, considering the many scientific and engineering interests and viewpoints on permafrost and related physical, chemical, geological, biological and engineering problems on both an interdisciplinary and international basis; and

WHEREAS the significant advancement made toward cooperative, systematic, interdisciplinary, international study and assessment of permafrost phenomena made through conferences such as this first International Conference on Permafrost has been demonstrated to contribute immeasurably to scientific and engineering progress; now, therefore,

BE IT RESOLVED that this conference urges that a second International Conference on Permafrost be planned and held with the objectives of further interdisciplinary support and participation, and

BE IT FURTHER RESOLVED that the Planning Committee for the first International Conference on Permafrost be requested to form an interim committee of international, interdisciplinary character to foster and encourage a second International Conference on Permafrost, and

BE IT FURTHER RESOLVED that copies of this resolution be forwarded to the National Academy of Sciences—National Research Council, and to all participants, sponsors, and cooperating organizations in the first International Conference on Permafrost.

SCIENCE

ENGINEERING

Underground Cold War

Up north around the Arctic Circle, scientists and engineers have been engaged for years in a cold war that knows no politics. From both sides of the Iron Curtain, volunteers enlist in the fight against a common enemy: permafrost, the iron-hard layer of dirt and rock bonded together by year-round ice. Permafrost underlies 20% of the earth's land area. It is 150 ft. thick at Fairbanks, Alaska, more than 2,000 ft. thick beneath the Taimyr Peninsula in Russia. Permafrost blocks well shafts, freezes oil drills, makes water piping and sewage disposal costly, heaves up 5-ft. hummocks in airport runways. Thawed, it only gets worse. Heated buildings tilt on their softened foundations. Blacktop highways often absorb enough heat to melt their way downhill.

Last week Western and Soviet permafrost experts got together at Purdue for a five-day conference on ways and means of heating up their underground cold war. Eventually the assembly settled down to develop two lines of strategy—attack and conservation.

The five-man Russian team, in particular, seemed interested in large-scale efforts to get rid of permafrost at mining or construction sites. Pointing out that massive blasting is too expensive, it offered plans for melting permafrost by solar heat trapped beneath huge sheets of plastic, and for electrifying the ground to move aside the water that makes permafrost so unreliable during partial thaws.

Others at the conference, conceding that the Russians talk with the authority of experience dating back to the 19th century construction of the trans-Siberian railroad, nonetheless found such schemes too far out.

U.S. scientists described the aerial mapping techniques that were used with great success to pick relatively solid sites for DEW line stations. Norwegian engineers explained how simple insulation prevents frost-heaving beneath their rail lines. Refrigerated well linings were described as an approach to keeping permafrost in place, but refrigerated building foundations, widely heralded a few years back, were rejected as too expensive to be practical.

ALASKA HOUSE SINKING INTO PERMAFROST
Where a thaw just makes matters worse.

The conferees faced up to the fact that as the north grows in population and economic importance, some permafrost problems will become more severe. Sanitary Engineer Amos Alter, 47, chief engineer of the Alaska Department of Health, detailed some of the elaborate methods now being tried for heating and pumping sewage in his burgeoning cities. And in a far-out speculation of his own, he suggested that in the future arctic liquids and wastes could be purified and recycled in "some sort of closed-circuit arrangement" that would treat whole cities in the manner now planned for two-man space capsules.

NAVIGATION

Easy Accuracy at Sea

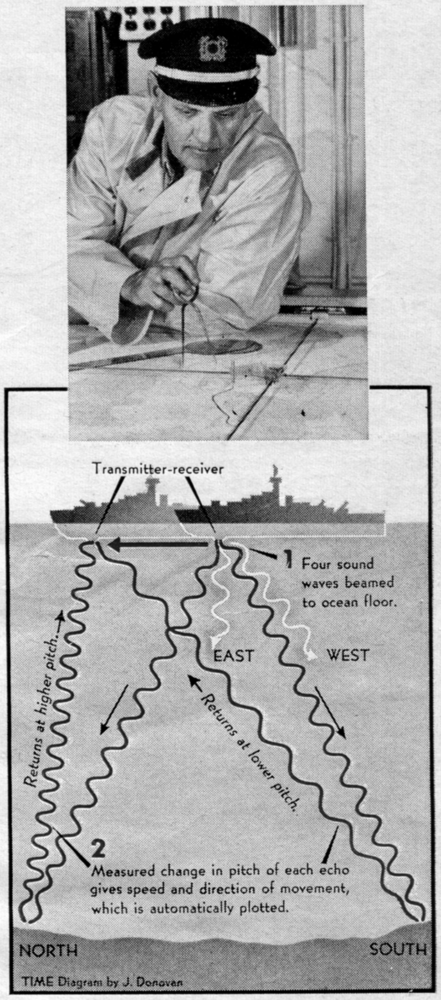
Deep below deck, with all the mindless certainty of a Ouija board, a marking pen moved by steel fingers glided across a nautical chart of Narragansett Bay. As he followed the pen's thin red line, a Navy lieutenant, cut off from any view of the water, telephoned commands to the bridge. At each command, the helmsman altered course, and the 65-ft. test ship *Alan* threaded neatly among islands and inlets. Each change in direction and speed was instantly recorded by the moving pen.

Delicate Marriage. The easy accuracy of the Raytheon navigator that the *Alan* was demonstrating for the Navy last week masked a delicate marriage of intricate techniques: the sonar sound-detection systems that have been used by submarines and sub detectors since World War II, and the more advanced electronic navigation devices that have recently come into use aboard high-speed aircraft. Mounted beneath the *Alan's* hull are four small pairs of sound projectors and receivers. A gyrocompass keeps them constantly aimed toward the cardinal points of the compass as powerful beams of sound are caromed off the ocean floor and picked up again.

The noise that comes back from the bottom is changed in frequency by the movement of the ship. This easily detected frequency shift is the celebrated Doppler effect, and a computer translates the change into speed-and-direction instructions for the automatic marking pen. A single dial adjusts the navigator to the scale of any standard marine chart. And last week's sea trial found the new Doppler sonar accurate within a startling 20 yds.

Man Overboard. Now that his newest brainchild has proved such a prodigy, Sonar Engineer Edwin Turner, 64, plans to deliver two prototypes to the Navy for further trials and then retire. He stresses that Doppler sonar is a supplement, not a replacement for radar and other modern navigational aids. It can function properly only in well-charted waters or far at sea, where the course picked out by its pen is not likely to run into unexpected obstacles. The Navy already has a built-in need for such a device on many of its ships, and along the world's coastlines, where the bulk of merchant shipping still plies its way, the new navigator may soon prove indispensable. Though the first commercial models may cost upwards of $10,000, the price is expected eventually to come within pocketbook range of the well-heeled amateur skipper.

In the most dramatic test of the new navigator last week, a sailor-sized, life-jacketed dummy nicknamed "Oscar" was pitched off the stern. At the shout "Man overboard!", the lieutenant in the hold marked the chart and began barking commands. When the red line had curved back on itself, there was Oscar, 10 yds. to port, in more danger of being run down than drowned.



SKIPPER* & DEVICE AT WORK
Like an undersea Ouija board.

* Raytheon's Maxson Langworthy.

Schmeisser, Institute of Inorganic Chemistry, Aachen). Iodine trifluoride yields the complexes IF_2BF_4, IF_2AsF_6, IF_2SbF_6; chlorine monofluoride yields $ClBF_4$, $ClAsF_6$, $ClSbF_6$. As reported several years ago, the low-temperature fluorination of ICl yields progressively IClF, $IClF_2$, and IF_3. Present evidence indicates that the molecular formulas of the compounds are $I \cdot ICl_2$, $IF_2 \cdot ICl_2$, $IF_2 \cdot ICl_2F_2$, and $IF_2 \cdot IF_4$, respectively. The reaction of IF_3 with iodine does not produce three molecules of IF, as previously indicated, but yields the adduct $IF_3 \cdot I_2$.

LAWRENCE STEIN
Argonne National Laboratory, Argonne, Illinois

Permafrost

About 20 percent of the land area of the earth (50 percent of Canada and the Soviet Union) is located in climatic zones where the mean annual temperature falls below 0°C. As a consequence, the phenomenon of freezing a thin surface crust of soil during the winter months, so familiar in more temperate climates, is reversed; the underlying soils or rocks remain perennially frozen while a thin surface layer ("active zone") temporarily thaws during the summer months. This latter condition is known as permafrost.

The soils in permafrost areas vary from coarse gravels to silts and organic peats and mucks (muskeg). Occasionally plastic clays are encountered. Depending on the soil type and on the drainage and climatic conditions, the proportion and distribution of ice in the ground may vary widely, ranging from partially filling the void spaces between soil particles to lenses and wedges of ice in thicknesses of a few centimeters, to massive zones of ice with dimensions to be measured in meters and even decimeters. Spectacular surface features often manifest themselves either as striking individuals, such as the "pingo" (Fig. 1), or as repetitive patterns over large areas, such as "ice-polygons" (Fig. 2). In recent years, interest in scientific studies of these features has heightened with promising signs of better understanding in such disciplines as geomorphology, glaciology, and historical geology. Moreover, the increasing importance of the arctic (and antarctic) regions, from both military and civilian standpoints, necessitated construction of roads, railways and airfields, dams, water distribution and sewage disposal systems, and structures for all kinds of purposes. Because of limited knowledge and the short time that could be allowed to elapse between the conception of a project and its completion, the design problems involved have been solved by judicious combinations of research, engineering analyses, field experience, and ingenuity. More complex and diverse projects involving the exploitation of mineral resources and the development of electric power on a large scale are now in the offing, requiring more accurate analyses if safe, economic designs are to be achieved.

On 11–15 November 1963 nearly 300 engineers and scientists from 12 countries gathered at Purdue University, Lafayette, Indiana, for the 1st international conference on permafrost. The proceedings of the conference will contain the latest maps defining the occurrence and distribution of permafrost in Eurasia, Alaska, and Canada. New information on permafrost areas reveals that their southern boundaries creep ever further southward—that is, localities heretofore thought to be free of permafrost are now known to have at least sporadic permafrost areas. In fact, permafrost has been discovered near Thompson, Manitoba, and even on Mount Washington, New Hampshire. Air photographs and geophysical methods have been helpful in making these surveys, although additional refinements are necessary where areas of sporadic permafrost are encountered. Vegetal cover may prove promising in this connection and the appearance of lichenaceous cover and the higher incidence of polyploidy are thought to occur where there is permafrost.

Soil genesis in permafrost country, as related to geomorphic conditions, offers a medium of understanding as attractive as that gained by correlating plant communities with soil types, and can even be used where no plants occur. The mechanics of surface-salt accumulation with upward movement of water and the association of soil salinity relations with the "active frost zone" indicate a basis for useful field comparisons and determination of site history. The existence in the normal Arctic soil profile of a permanently frozen organic layer generally 5 to 15 cm thick at a depth of 40 to 130 cm below the surface was reported, and it was suggested that this organic layer represents an accumulation during an abrupt warming of the arctic regions.

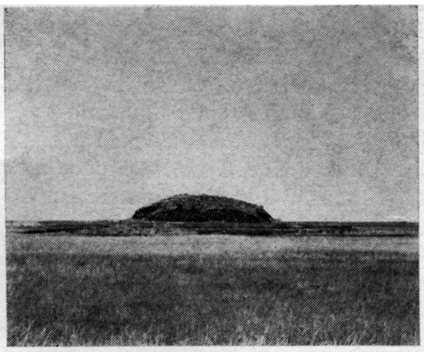


Fig. 1. Pingo, partially eroded by waves, on an alluvial island in the Mackenzie delta. The pingo is 7.62 m high and consists of a central core of ice doming up 1.5 to 3 m. [J. Ross McKay]

Carbon-14 dating indicated the age of the warming to be 8000 to 10,000 years. It is worth noting that soil-forming processes are active in the ice-free Lower Wright Valley, Antarctica, under conditions void of humus and almost continuous freezing temperatures.

Criticism was made of conventional procedures for calculating thermal changes caused by impounding water or constructing roads and buildings. First, air temperature is only one variable governing the net heat balance at the air-ground interface; in permafrost areas ground and cloud cover may play equally decisive roles. Second, an unfrozen film of water persists around fine grained particles in frozen soils and the percentage of unfrozen water present is dependent on soil type and temperature (and to a secondary degree on the salt content in the pore water). Thus the heat released at the freezing front is not equal to the volumetric latent heat times the total volume of

Fig. 2. Patterned ground near Point Barrow, Alaska. [Philip Johnson, Cold Regions Research and Engineering Laboratories]

water present in the soil pores, and latent heat is released (or absorbed) behind the freezing front depending on the temperature distribution. Moreover, the latent heat from fusion of ice formed from soil water may be different from that of bulk water due to soil-water interaction forces. Third, the Fourier heat equation, which implies conduction of heat only, does not adequately describe the heat-flow process as water is moved to the freezing front by hydraulic and thermal gradients. Some investigators believe in the existence of a "threshold" gradient—either hydraulic or thermal—that must be exceeded before water will commence to flow at all. However, experiments to date have not been sufficiently conclusive to convince all skeptics. It is evident that these matters are subjects for intensive research if reliable predictions of changes in thermal regime are to be accomplished.

The uncertainties that remain in the measurement and prediction of the mechanical properties of frozen ground were brought sharply into focus. That the deformation process is strongly dependent on time and temperature has long been recognized. Rheological models to predict overall behavior have been formulated and described mathematically. Even if this phenomenological approach to the problem is successfully developed (although we are still far from reaching this stage) it will hardly be possible to scale the results of laboratory experiments to prototype conditions without due cognizance of the main physical processes involved—such as refreezing of water and melting of ice during creep and the movement of mineral particles by the freezing process. In the interim, such questions as the adfreezing strength of frozen ground around embedded piles, the long-term bearing capacity of footings and caissons, and the magnitude and time-rate of the deformations to be expected, will continue to be determined on a semi-empirical basis—a situation that is not too heartening in the face of the larger and more complex projects currently being contemplated in the far North. The proposed Rampart Dam, on the Yukon River northwest of Fairbanks, Alaska, is a case in point. If completed, the dam will impound a body of water larger and deeper than Lake Erie.

Considerable progress in soil exploration and site selection was recorded. The role of logistics and of climate and terrain variables is now well understood. The use of indirect methods, such as topographic maps, airphoto interpretation, and vegetal cover as aids in site selection has been carefully documented. Seismic and electrical resistivity techniques have been adapted for mapping the thickness of the "active zone" and the depth to rock, as well as the thickness of permafrost over large (and even relatively small) regions. Core-drilling techniques using refrigerated drilling fluids have been developed and relatively undisturbed samples of all types of frozen ground can now be obtained at costs that are no longer prohibitive. Precision thermistors for measuring ground temperatures with an accuracy better than 0.02°C are available. The most favorable sites for a given project can readily be selected, and detailed data on subsurface conditions can be obtained economically. The element of "surprise" previously considered acceptable in permafrost construction is no longer excusable.

Workable design practices for many common engineering problems have evolved. Water mains and sewers are carried above ground in insulated "utilidors." Planned wastage or the circulation of heated water, to prevent freezing of water supply lines, is monitored and carefully controlled. The location of dependable water supplies is often a serious problem. For example, at Kotzebu, Alaska, it was found necessary to reclaim sea water to service the hospital and school. Experiments are under way to treat and recirculate waste water (and even sewage) for entire cities by procedures similar to those used in space capsules. Highways and airfields have been successfully constructed by maintaining the ground cover and providing a sufficient thickness of nonfrost-susceptible granular base, with good drainage conditions, to avoid thawing of permafrost during the short summer season.

Large-scale earthworks, such as may be encountered in open pit mining or in the diversion of rivers, involve enormous energy requirements. Nuclear blasting has been considered, and small-scale experiments conducted, but to our knowledge no project of this type has thus far been attempted. Increasing the temperature (and even thawing) of permafrost with solar radiation over areas covered with plastic sheets, or the application of artificial heat, has been used in the Soviet Union in an effort to reduce the energy requirements. To date, mechanical energy such as conventional blasting, rippers, and power shovels have proved to be more economical.

The conference was sponsored by the School of Civil Engineering at Purdue University and presented by the Building Research Advisory Board of the National Academy of Sciences–National Research Council. Supporting agencies were National Science Foundation, U.S. Army Corps of Engineers (Cold Regions Research and Engineering Laboratories), U.S. Navy Bureau of Yards and Docks, U.S. Air Force Cambridge Research Laboratories (Terrestrial Sciences Laboratory), Office of Civil Defense, Bureau of Public Roads, Caterpillar Tractor Company, U.S. Army Materiel Command, U.S. Public Health Service, and Office of Naval Research.

Cooperating agencies included the National Research Council of Canada, Associate Committee on Snow and Soil Mechanics; American Society of Civil Engineers, Soil Mechanics and Foundations Division; American Society for Testing and Materials, Division of Materials Sciences; American Geophysical Union; and the Highway Research Board of the National Academy of Sciences–National Research Council.

Proceedings will be available in the summer of 1964 and may be obtained by writing to Building Research Advisory Board, National Academy of Sciences, 2101 Constitution Avenue, NW, Washington, D.C.

K. B. Woods
G. A. Leonards
Purdue University,
Lafayette, Indiana

Forthcoming Events

March

9–10. **Aerodynamic Testing** Conf., American Inst. of Aeronautics and Astronautics, Washington, D.C. (J. N. Fresh, David Taylor Model Basin, Code 630, U.S. Navy, Washington, D.C.)

10–14. American Inst. of **Chemical Engineers**, New Orleans, La. (AIChE, 345 E. 47 St., New York 17)

11–12. Instrument Soc. of America, 14th conf. on **instrumentation** for the iron and steel industry, Pittsburgh, Pa. (N. F. Simcic, Research Laboratory, Jones and Laughlin Steel Corp., 900 Agnew Rd., Pittsburgh 30)

11–13. National Federation of **Science Abstracting and Indexing Services**, annual, San Antonio, Tex. (R. A. Jensen, The Federation, 324 E. Capitol St., Washington, D.C.)

12. **Interplanetary Monitoring Platform**

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and Remembrance of C.W. Lovell

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