

Permafrost protection by thermosyphon under the paved road in West Mongolia

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ABSTRACT

According to the results of field studies, asphalt pavement increases the absorption of solar radiation and the accumulation of snow or water in the channels on both sides of the road, accelerating the thawing of permafrost under it, and due to this process, waves form on the asphalt surface and driving on it at normal speed becomes dangerous. Field measurements show that the rate of permafrost thawing under natural conditions is 0.5–2.0 cm per year, and permafrost thawing under paved roads is 5–10 times faster than under natural conditions. In 2021–2022, in close cooperation with construction companies, government officers, and permafrost experts, a road with a thermosyphon embankment was built in an ice-rich permafrost area along the western road corridors at six selected road sections. On December 1, 2022, the ground temperature dropped to -14 °C and -20 °C at the evaporator, while in the ground between the thermosyphons dropped to -8 °C or -9 °C. These temperatures increased to +1.6 °C and -0.7 °C at the evaporator and to -0.9 °C and -2.2 °C between thermosyphons. In Mongolia, the thermosyphon works very well, but under the paved road above the evaporators, it is necessary to install pretty good insulation.

1 INTRODUCTION

Permafrost can be understood as a mixture of frozen ground and ice. Under natural conditions, ice contents are different along the permafrost profile. Due to climate warming, permafrost degrades differently, and it degrades faster in Mongolia because Mongolian permafrost is

characterized by sensible permafrost with a temperature close to zero degrees (Sharkhuu et al. 2011; Jambaljav et al. 2013, 2017; Ishikawa et al. 2018; Yamkhin et al. 2022).

More than 1,400 km of Mongolian roads pass through the permafrost regions (Figure 1), and some parts of these roads on ice-rich permafrost are damaged.

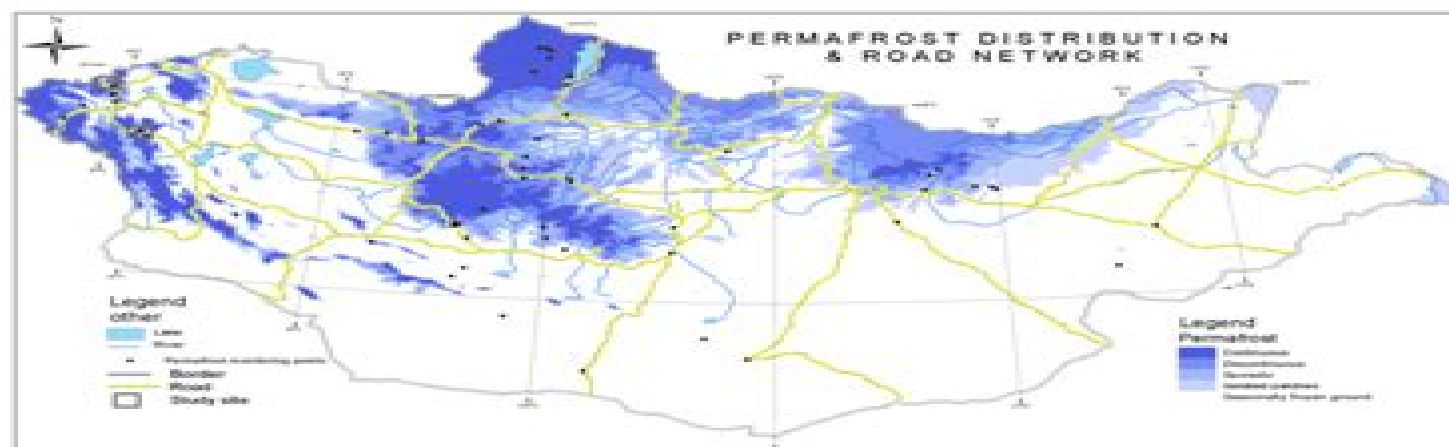


Figure 1. Permafrost distribution and road network over Mongolia.

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Climate Change, Permafrost, and Impacts on Civil Infrastructure, 2003 **Papers from the International Symposium on the Verification of Cryospheric Models** Konrad Steffen, 2000 Thawing Permafrost J. van Huissteden, 2020-01-01 This book provides a cross disciplinary overview of permafrost and the carbon cycle by providing an introduction into the geographical distribution of permafrost with a focus on the distribution of permafrost and its soil carbon reservoirs The chapters explain the basic physical properties and processes of permafrost soils ice mineral and organic components and how these interact with climate vegetation and geomorphological processes In particular the book covers the role of the large quantities of ice in many permafrost soils which are crucial to understanding carbon cycle processes An explanation is given on how permafrost becomes loaded with ice and carbon Gas hydrates are also introduced Structures and processes formed by the intense freeze thaw action in the active layer are considered e g ice wedging cryoturbation and the processes that occur as the permafrost thaws pond and lake formation erosion The book introduces soil carbon accumulation and decomposition mechanisms and how these are modified in a permafrost environment A separate chapter deals with deep permafrost carbon gas reservoirs and recently discovered methane emission phenomena from regions such as Northwest Siberia and the Siberian yedoma permafrost Workshop on Permafrost Data Rescue and Access Roger Graham Barry, J. Alan Heginbottom, Jerry Brown, 1995 *Natural Gas Hydrate in Oceanic and Permafrost Environments* M.D. Max, 2003-05-31 This is the first book published on the emerging research field of naturally occurring gas hydrates focusing on methane hydrate that is not primarily a physical chemistry textbook This book is designed as a broad introduction to the field of hydrate science demonstrating the significance of the hydrate cycle to energy resource potential seafloor stability and global climate and climate change along with other issues The best known hydrate localities are described as are research and laboratory methods and results The book consists of chapters grouped in related themes that present up to date information on methane hydrate Each of the contributing authors is expert in hydrate science and most have been carrying out research in hydrate for a considerable time Audience This book will be an important source of information for marine geologists geophysicists geochemists and petroleum geologists and regulators It is also intended as a graduate level textbook

Geological Survey of Canada, Current Research (Online) no. 2000-E14 , **Proceedings of the 16th World Congress of Soil Science on CD-ROM** , 1998 Full text and summaries of conference papers Index of Conference Proceedings British Library. Document Supply Centre, 2000 **Library & Information Science Abstracts** , 1999 Natural Gas Hydrates Timothy S. Collett, Art Johnson, Camelia C. Knapp, Ray Boswell, 2010-01-14 Hardcover plus CD U.S. Geological Survey Professional Paper , 1984 *Engineering Geology and Geomorphology of Glaciated and Periglaciated Terrains* J.S. Griffiths, C.J. Martin, 2017-10-18 The Engineering Group of the Geological Society Working Party brought together experts in glacial and periglacial geomorphology Quaternary history engineering geology and geotechnical engineering to establish

best practice when working in former glaciated and periglaciated environments The Working Party addressed outdated terminology and reviewed the latest academic research to provide an up to date understanding of glaciated and periglaciated terrains This transformative state of the art volume is the outcome of five years of deliberation and synthesis by the Working Party This is an essential reference text for practitioners students and academics working in these challenging ground conditions The narrative style and a comprehensive glossary and photo catalogue of active and relict sediments structures and landforms make this material relevant and accessible to a wide readership

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1950-1975 Cold Regions Research and Engineering Laboratory (U.S.),1992 **World Databases in Geography and**

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Treatise on Geomorphology ,2013-02-27 The changing focus and approach of geomorphic research suggests that the time is opportune for a summary of the state of discipline The number of peer reviewed papers published in geomorphic journals has grown steadily for more than two decades and more importantly the diversity of authors with respect to geographic location and disciplinary background geography geology ecology civil engineering computer science geographic information science and others has expanded dramatically As more good minds are drawn to geomorphology and the breadth of the peer reviewed literature grows an effective summary of contemporary geomorphic knowledge becomes increasingly difficult The fourteen volumes of this *Treatise on Geomorphology* will provide an important reference for users from undergraduate students looking for term paper topics to graduate students starting a literature review for their thesis work and professionals seeking a concise summary of a particular topic Information on the historical development of diverse topics within geomorphology provides context for ongoing research discussion of research strategies equipment and field methods laboratory experiments and numerical simulations reflect the multiple approaches to understanding Earth s surfaces and summaries of outstanding research questions highlight future challenges and suggest productive new avenues for research Our future ability to adapt to geomorphic changes in the critical zone very much hinges upon how well landform scientists comprehend the dynamics of Earth s diverse surfaces This *Treatise on Geomorphology* provides a useful synthesis of the state of the discipline as well as highlighting productive research directions that Educators and students researchers will find useful Geomorphology has advanced greatly in the last 10 years to become a very interdisciplinary field Undergraduate students looking for term paper topics to graduate students starting a literature review for their thesis work and professionals seeking a concise summary of a particular topic will find the answers they need in this broad reference work which has been designed and written to accommodate their diverse backgrounds and levels of understanding Editor in Chief Prof J F Shroder of the University of Nebraska at Omaha is past president of the QG G section of the Geological Society of America and present Trustee of the GSA Foundation while being well respected in the geomorphology research community and having won numerous awards in the field A host of noted international geomorphologists have contributed state of the

art chapters to the work Readers can be guaranteed that every chapter in this extensive work has been critically reviewed for consistency and accuracy by the World expert Volume Editors and by the Editor in Chief himself No other reference work exists in the area of Geomorphology that offers the breadth and depth of information contained in this 14 volume masterpiece From the foundations and history of geomorphology through to geomorphological innovations and computer modelling and the past and future states of landform science no stone has been left unturned *EcoRegions of Alaska* Alisa L. Gallant,1998-05 Produced as a framework for organizing and interpreting environmental data for inventory monitoring and research efforts The descriptions of the 20 ecoregions of Alaska contained in this guide were derived by synthesizing information on the geographic distribution of environmental factors such as climate terrain soils and vegetation The specific procedures and materials used to delineate the ecoregion boundaries are documented and the environmental characteristics in each ecoregion are described Accompanied by a full color oversize map of the ecoregions their boundaries and transitional areas 42 full color photos **Monthly Catalog of United States Government Publications** ,1998-07 **New Publications of the U.S. Geological Survey** ,1992 **New Publications of the Geological Survey** Geological Survey (U.S.),1991 *NYRocks '97* ,1997

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