Gas Hydrates Quarterly Report
FWP-42724
Part 1:
The DoE Satellite Imaging Gas Hydrate Exploration Area

Objectives:

This project has three objectives: to investigate the potential of Comparative Information Theory (CIT) for improving the processing of the seismic signature from gas hydrate seismic boundary reflectors, and of satellite imagery for mapping lineaments; to design and develop a prototype, portable *in situ* logging system that utilizes Raman spectroscopy to image subsea hydrates in wellbores or for remote detection of methane clathrates in an ocean environment; and to adapt and transfer unique PNNL technology (ultrasonic and other precision measurement capabilities) to monitor the metamorphosis of gas hydrates during drilling and production.

Comparative Information Theory (CIT) Imagery Analysis.

The Multispectral Thermal Imager (MTI) data collection (http://www.mti.sandia.gov)

Purpose. Using the MTI core capability of high spatial resolution in thermal region with multiple thermal bands for oil and gas exploration. The thermal imagery collection effort is continuing to take advantage of the unprecedented capability of the DOE satellite. Cooperation between DoE NA-22 and this project has been excellent. As the field data collection indicates, North Slope is a very challenging location on Earth to collect satellite data because of the frequent cloud coverage. Out of more than dozen collections scheduled to image the Prudhoe Bay area, fortunately two collections are free of clouds.

Background. MTI is a space-based research and development project sponsored by the U.S. Department of Energy (DOE), Office of Nonproliferation and National Security. MTI's primary objective is to demonstrate advanced multispectral and thermal imaging, image processing, and associated technologies that could be used in future systems for detecting and characterizing facilities producing weapons of mass destruction. The MTI system consists of a single satellite in polar, 360-mile-high orbit carrying an advanced multispectral and thermal imaging sensor. During its 3-year mission, the MTI satellite will periodically record images of participating government, industrial, and natural sites in 15 spectral bands, ranging from visible (5m resolution) to long-wave infrared (20m resolution). Spectral bands can be thought of as colors, although only 3 of the 15 are visible to the human eye. These spectral bands, along with MTI's very accurate radiometry, make it unique among current and planned space-based imaging systems. MTI's spectral bands are carefully selected to collect data needed to derive a broad range of information on facilities and activities, including surface temperatures, materials, water quality, and vegetation health. To enhance accuracy, additional bands provide simultaneous information on atmospheric water vapor, aerosol content, and sub-visual cloud presence. For comparison, Landsat 7 has 30m UV/VIS and 60m thermal band spatial resolutions.

Location Map. Figure 1 depicts the location of the two successful MTI data collects using Landsat as the background. The Landsat images are part of a worldwide mosaic using imagery from 90's. Individual MTI frames are labeled 1 through 4 with white and blue color indicating two different collects.

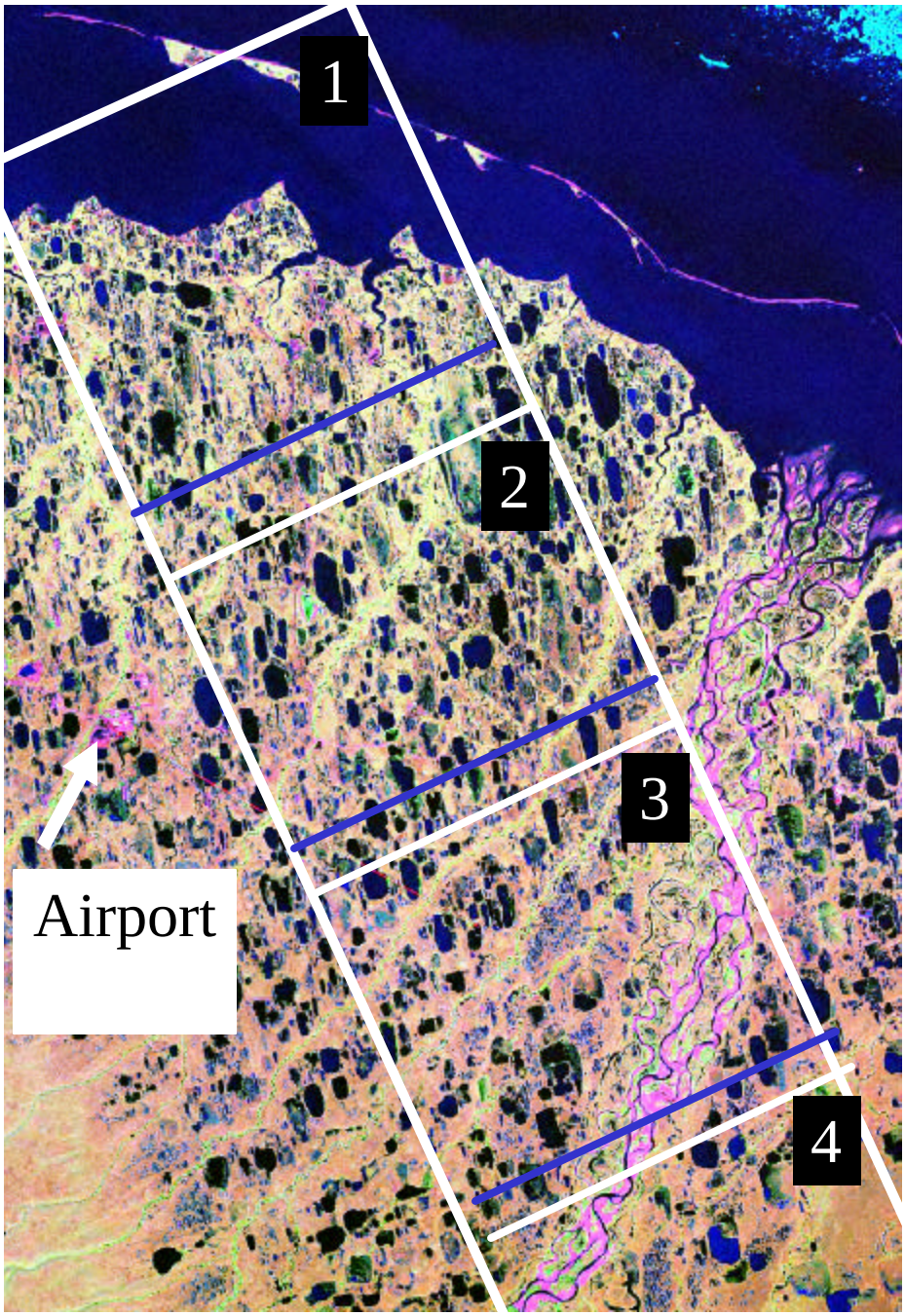

Figure 1: MTI ground track at Prudhoe Bay Area over Landsat footprint.

MTI image. Figure 2 is an image chip in Frame No. 3 (Figure 1). This 3-band composite maps largely the surface emissivity of the gas hydrates exploration region in Prudhoe Bay area. The signal of the MTI has range and variability quite different from that of Landsat, thus providing data for surface observable useful for geological interpretations.

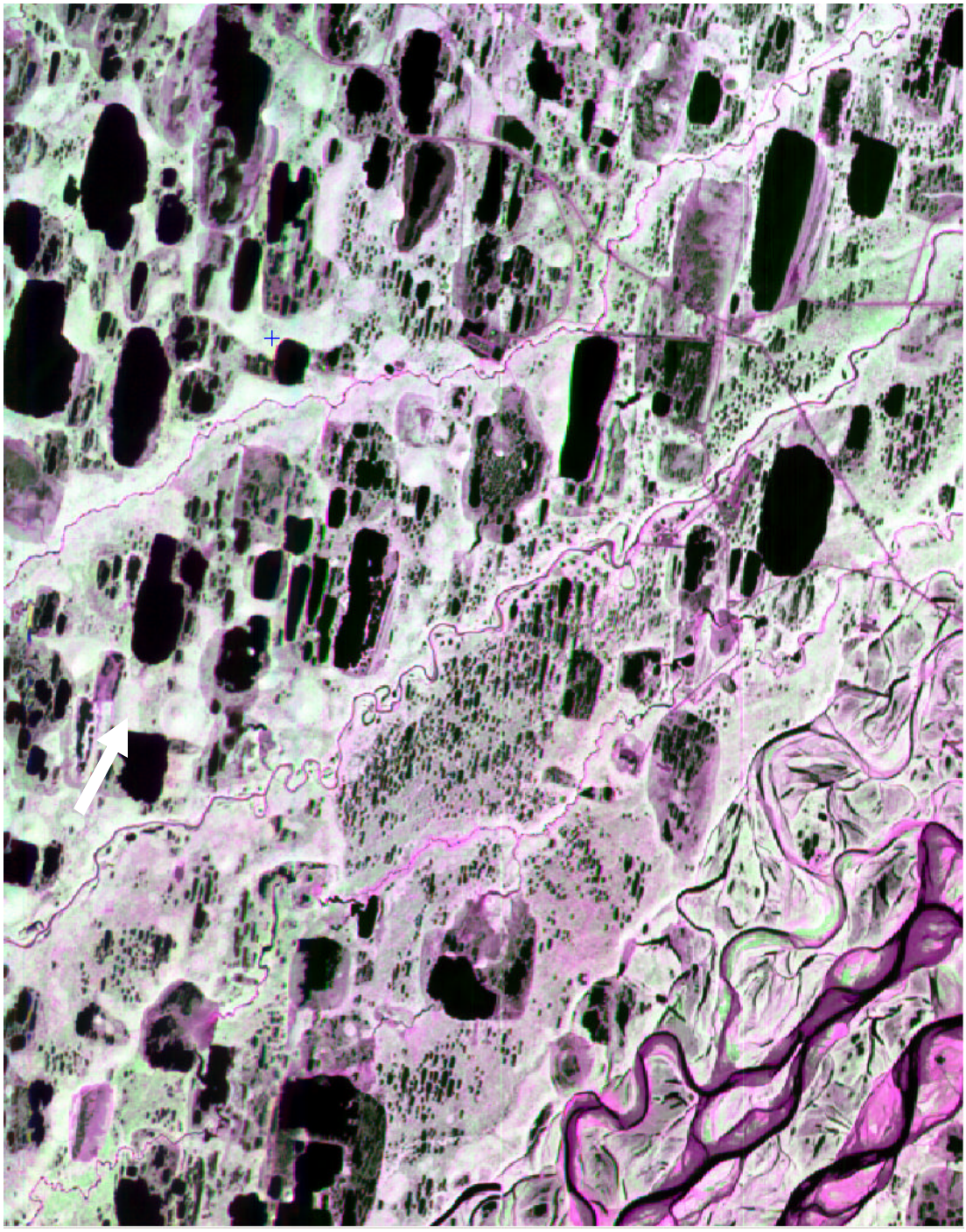

Figure 2: False color image using MTI band 6,12,7. The evolution of lakes and their geometric configuration are quite visible.

The analysis of individual image frames and comparison between Landsat imaged during 90's and the current MTI indicates the Lakes are dynamics. The changes in shape, size, location, and intensity provide scientific observable for potential shallow subsurface geological structures.

Future Plan: There are total 8 frames of imagery free from clouds collected at this site. More are in the process of acquiring and processing. Because very limited surface relief proving little useful information for surface geology; remotely sensed data is a providing a unique data set to fill this gap. Current plan is to continue the MTI date collection, imagery analysis, and CIT algorithm development for automatic lineament extraction.

Part2:

Ultrasonic Characterization of

Hydrated Laden Slurries and Drilling Muds

The following publications have supported the development of the sensing system for use for real-time process characterization of hydrates during production. This research has been integrated into a multi-sensor probe for interrogation of physical properties of the drilling mud and the hydrate-laden slurry. The sensor, shown in Figure 1, uses multiple frequencies to interrogate the multi-component slurry. The transducers range in frequency from 0.5 to 7.5 MHz and include both narrow and broad-band signals. The frequency range permits interrogation of more dense slurries and drilling muds.

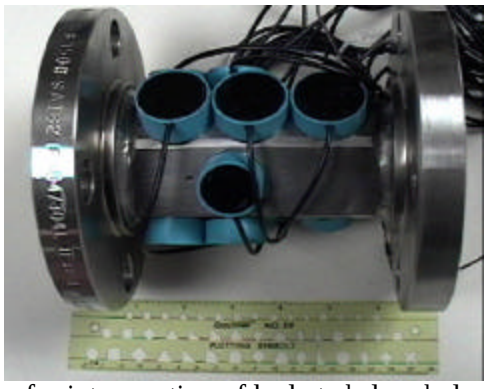

Figure 1. Spoolpiece for interrogation of hydrate laden sludges and drilling muds.

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