U.S DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

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PLATE 2 OF 3

DESCRIPTION OF SPECTRAL UNITS

Wet vegetated sandy mud– ~45%–50% water, ~45%–50% dead or senescent (brown, no chlorophyll) and live (green, chlorophyll) grass, and <5% sandy mud exposed at surface

Dry vegetated sand– ~20% live (green) vegetation, 75% dead or senescent (brown no chlorophyll) vegetation, and <5% bare sand. In some areas such as on parabolic dunes, the vegetated sand spectral unit consists of ~20% lichen, ~20% bare sand, ~40% dead vegetation and ~20% green vegetation

Slightly muddy sands– <95% quartz sand, >5% live (green) vegetation, silt, and clay

Clean sands–>95% quartz sand, <5% live (green) vegetation, silt, and clay

Green vegetation– >50% green vegetation cover

Water and Ice–100% water and/or ice

Unclassified

EXPLANATION OF MAP SYMBOLS

Federal Boundary—National Petroleum Reserve, Alaska

Existing Pipeline

Proposed Pipeline Route (approximate, acquired 5/04)

Exploration Well

Proposed Pad (approximate, acquired 5/04)

SCALE 1:63 360

1 MAP INCH = 1 GROUND MILE

MAP LOCATION

APPROXIMATE MEAN DECLINATION, 2004

Landsat 7 ETM+ data acquired June, 2003
Universal Transverse Mercator projection, zone 5
1983 North American Datum

SURFACE CLASSIFICATION MAP OF THE FISH CREEK AREA, HARRISON BAY QUADRANGLE, NORTHERN ALASKA

INTRODUCTION

The northeastern part of the National Petroleum Reserve in Alaska (NPRA) has become an area of active petroleum exploration during the past five years. Recent leasing and exploration drilling in the NPRA requires the Bureau of Land Management (BLM) to manage and monitor a spectrum of surface activities that include seismic surveying, exploration drilling, oil-field development drilling, construction of oil-production facilities, and construction of pipelines and access roads. BLM evaluates a variety of permit applications, environmental impact studies, and other documents that require rapid compilation and analysis of data pertaining to surface and subsurface geology, hydrology, and biology. In addition, BLM must monitor these activities and assess the impacts of these activities to the natural environment. Timely and accurate completion of these land-management tasks requires elevation, hydrologic, geologic, petroleum-activity, and cadastral data, all integrated in digital formats at a higher resolution than currently available in published formats.

To support these land-management tasks, a series of maps have been generated from remotely sensed data in an area of high petroleum-industry activity. The maps, extending from 70°00’ to 70°30’ N latitude and from 151°00’ to 153°10’ W longitude, include the Alpine oil field on the east, the Husky Inigok exploration well (site of a landing strip) on the west, many of the exploration wells drilled in NPRA since 2000, and the route of a proposed pipeline to carry oil from discovery wells in NPRA to the Alpine oil field. This map area is referred to as the “Fish Creek area” after the prominent fluvial system within the area.

The map series includes a color shaded-relief map (based on 5 m-resolution data, Plate 1), a surface classification map (based on 30 m-resolution data, Plate 2), and a pan-sharpened, shaded relief-surface classification map (generated by fusing the two datasets, Plate 3). Remote sensing datasets used to compile the maps include, IFSAR, and Landsat 7 ETM+ data. In addition, a 1:250,000 geologic map of the Harrison Bay Quadrangle, Alaska (Carter and Galloway, 1985) has recently been released in digital format (Carter et al., 2005), and was used in conjunction with ETM+ and IFSAR data.

DATA DESCRIPTION

The Landsat 7 ETM+ radiance-at-the-sensor data were acquired on June 6, 2003, and consist of six bands at 30 m resolution in the 0.4 to 2.5 µm region, one band at 90 m resolution centered at 11.45 µm, and one 15 m resolution panchromatic band. The thermal infrared and panchromatic bands were not used in this study. The Landsat 7 ETM+ scene was calibrated to reflectance using an ENVI (Environment for Visualizing Images) reflectance algorithm (RSI, 2000). Evaluation of the reflectance data indicated that values in bands 1-4 were anomalously high, and thus, a dark object subtraction method (Crain, 1971) was used to correct for the optical scattering of light in bands 1-4. A subset of the reflectance Landsat 7 ETM+ scene was then extracted to cover the NPRA study area.

[illegible]

low reflectance in band 7, and a relatively low albedo when compared to other spectral units. Field observations indicate that the wet vegetated sandy mud spectral unit consists of approximately 45 to 50 percent water, approximately 45 to 50 percent dead or senescent (brown, no chlorophyll) and live (green, chlorophyll) grass, and <5 percent sandy mud at the surface. Field spectra resampled to ETM+ bandpasses are very similar to image spectra taken from parts of the image classified as wet vegetated sandy mud. The field spectra illustrate a strong 0.7 µm chlorophyll absorption feature, and a low reflectance in the 2.0 µm to 2.5 µm region due to cellulose absorption from dead and live vegetation and water. The field spectra also have a lower albedo than other field spectra due to the presence of water. Thus, the spectral characteristics of wet vegetated sandy mud spectral unit are due to a mixture of live (green) and dead or senescent (brown) vegetation (low bands 3 and 7, respectively), and water (relatively low albedo compared to other spectral units).

The average spectrum of the dry vegetated sand spectral unit has a slight chlorophyll feature, high band 5 reflectance, low reflectance in band 7 and the highest albedo of all of the spectral units. Field data indicate that the dry vegetated sand unit consists of approximately 20 percent live (green) vegetation, 75 percent dead (brown) vegetation, and < 5 percent bare sand. In some areas such as on parabolic dunes, the dry vegetated sand spectral unit consists of up to 20 percent lichen and up to 20 percent bare sand. A field spectrum illustrates a 0.7 µm (ETM+ band 3) chlorophyll absorption feature. The field spectrum also illustrates high reflectance in the 1.4 to 1.8 µm region and low reflectance in the 2.0 to 2.5 µm region which is due to cellulose absorption. Quartzose sand also has high reflectance in the 1.4 to 1.8 mm region, which is partially responsible for the high band 5 reflectance of image spectra from the dry vegetated sand spectral unit. The spectral characteristics of the dry vegetated sand spectral unit are due small amounts of live (green) vegetation mixed with large amounts of dead (brown) vegetation, sand, and lichen.

Spectral shape comparisons of an averaged field spectrum (n-15) resampled to Landsat 7 ETM+ bandpasses and the average image spectrum of the dry vegetated sand spectral unit indicate that band 5 and band 3 reflectance are lower for field spectra, however, overall spectral shapes are similar. The field spectrum of dry vegetated sand is similar to the field spectra taken from an area that classifies as wet vegetated sandy mud. The lower band 3 and band 5 reflectance values of the field spectrum resampled to Landsat 7 ETM+ bandpasses are due to the seasonal changes in vegetation. The field spectra were recorded in mid summer when there was more live (green) vegetation than in early summer when the Landsat 7 ETM+ data were acquired. Green vegetation contains more chlorophyll and water than brown (senescent) vegetation, and would result in lower reflectance in bands 3 and 5. The increase in green vegetation later in the summer indicates that acquisition of data by visible to short-wave infrared detectors needs to occur in early summer when vegetation is still senescent.

The average image spectrum for the clean sand spectral unit has a small chlorophyll feature, high reflectance in bands 5 and 7, and lower albedo when compared to the average dry vegetated sand spectrum. The lower albedo of the clean sand average image spectrum may be due to surface moisture at the time of the Landsat data acquisition. Field observations indicate that the clean sand spectral unit primarily consists of quartz sand (approximately 95 percent) and minor amounts (<5 percent) of live (green) vegetation, silt, and clay. Quartz is spectrally flat and has high reflectance in the 1.5 to 2.4 µm region. Laboratory spectra of sand samples from dune blowout features indicate high reflectance from 1.5 µm to 2.5 µm with slight 2.20 µm and 2.35 µm absorption features due to muscovite. The high reflectance of bands 5 and 7 in the average spectrum of the clean sand spectral unit is due to the high percentage of quartz (>95 percent).

The slightly muddy sand spectral unit has a more intense absorption of band 7 than the clean sand spectral unit, and less intense chlorophyll absorption and higher albedo than the wet vegetated sandy mud spectral unit. Laboratory spectra of all of the sands from the study area have a 2.2 µm absorption feature that is typically associated with either muscovite or clays. Field observations also indicate that there is slightly more (>10 percent) silty mud and green vegetation in the muddy sand spectral unit than the clean sand spectral unit but less than the wet vegetated sandy mud spectral unit. The greater percentage of clay and (or) muscovite and green vegetation accounts for the deeper band 7 absorption feature in the slightly muddy sand unit than observed in the clean sand spectral unit.

Some pixels did not correlate with any of the spectral unit classifications. Field investigations in June 2004 indicated that some of the non-classified areas contained equal amounts of green and dead vegetation and up to 10 percent standing water. It was not possible to determine if this is a separate classification unit. Many of the unclassified pixels have different spectral signatures and several different spectral classes may be grouped in the non-classified category.

A single spectral unit, a combination of spectral units, or a combination of spectral units and non-classified pixels form patterns that define eolian, fluvial, deltaic, and marine depositional facies (Plate 2). The dry vegetated sand spectra primarily mapped deposits of eolian and marine sand located in the northwestern part of the study area. The wet vegetated sandy mud spectral unit primarily mapped muddier lake sediments of thaw lakes. Clean sand and muddy sand spectral units mapped recent sand bodies, including eolian blowout features, fluvial sand bars and deltaic deposits. A mixture of dry vegetated sand and green vegetation spectral units, and unclassified pixels mapped flood plain deposits in the eastern part of the study area.

On the basis of field and spectral data most of the spectral characteristics observed in NPRA are due to water, quartz sand, silty mud, live (green) vegetation, and dead or senescent (brown) vegetation. The primary spectral controls on dry vegetated sand are mixtures of live (green) and dead (brown) vegetation. Lake sediment spectral characteristics are primarily due to mixtures of live (green) vegetation, dead (brown) vegetation and water. The clean sand spectral unit is primarily quartz sand and muddy sand spectral unit is primarily quartz with small mixtures of silty mud, and vegetation.

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