Prepared in cooperation with the U.S. Department of Defense Task Force for Business and Stability Operations

A Summary of Data Collected by the U.S. Geological Survey at Dasht-e-Nawar, Afghanistan, in Support of Lithium Exploration, June–September 2014

By Lisa L. Stillings, Thomas J. Mack, Michael P. Chornack, Siddiq S. Kalaly, M. Idrees Ahmadi, and A. Qasim Akbar

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Conversion Factors

SI to Inch/Pound

Multiply	By	To obtain
	Length	
centimeter (cm)	0.3937	inch (in.)
millimeter (mm)	0.03937	inch (in.)
meter (m)	3.281	foot (ft)
kilometer (km)	0.6214	mile (mi)
	Area	
square meter (m^2)	0.0002471	acre
square kilometer (km^2)	247.1	Acre
square centimeter (cm^2)	0.001076	square foot (ft^2)
square meter (m^2)	10.76	square foot (ft^2)
square kilometer (km^2)	0.3861	square mile (mi^2)
	Volume	
cubic meter (m^3)	6.290	barrel (petroleum, 1 barrel = 42 gal)
liter (L)	0.2642	gallon (gal)
cubic meter (m^3)	264.2	gallon (gal)
cubic centimeter (cm^3)	0.06102	cubic inch (in^3)
cubic decimeter (dm^3)	61.02	cubic inch (in^3)
liter (L)	61.02	cubic inch (in^3)
cubic meter (m^3)	35.31	cubic foot (ft^3)
	Mass	
gram (g)	0.03527	ounce, avoirdupois (oz)
kilogram (kg)	2.205	pound avoirdupois (lb)
megagram (Mg)	1.102	ton, short (2,000 lb)
megagram (Mg)	0.9842	ton, long (2,240 lb)
metric ton per day	1.102	ton per day (ton/d)
megagram per day (Mg/d)	1.102	ton per day (ton/d)
megagram per day per square kilometer [$(Mg/d)/km^2$]	2.8547	ton per day per square mile [$(ton/d)/mi^2$]
megagram per year (Mg/yr)	1.102	ton per year (ton/yr)
metric ton per year	1.102	ton per year (ton/yr)
	Density	
kilogram per cubic meter (kg/m^3)	0.06242	pound per cubic foot (lb/ft^3)

Multiply	By	To obtain
gram per cubic centimeter (g/cm^3)	62.4220	pound per cubic foot (lb/ft^3)
	Energy	
joule (J)	0.0000002	kilowatthour (kWh)
	Radioactivity	
becquerel per liter (Bq/L)	27.027	picocurie per liter (pCi/L)

Temperature in degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) as follows:

°F=(1.8×°C)+32

Vertical and horizontal coordinate information is referenced to the World Geodetic System of 1984 (WGS 84).

Altitude, as used in this report, refers to distance above the vertical datum.

Specific conductance is given in microsiemens per centimeter at 25 degrees Celsius (µS/cm at 25°C).

Concentrations of chemical constituents in water are given either in milligrams per liter (mg/L) or micrograms per liter (µg/L).

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Abstract

The playa of the Dasht-e-Nawar basin, east-central Afghanistan, has historically been investigated for potential evaporate mineral deposits. In 2014, the U.S. Department of Defense Task Force for Business and Stability Operations contracted Centar American and SRK Consulting, Inc. to assess a potential lithium (Li) brine resource, conduct a basin gravity survey, and collect subsurface brines and sediments. The U.S. Geological Survey collaborated with this effort by providing analysis of Landsat imagery prior to, and during, field data collection; measurements of specific gravity of sediment and rock samples; oversight of passive seismic data collection and subsequent analysis; and an independent analysis of the chemistry and mineralogy of the subsurface samples. The Afghanistan Geological Survey collaborated by providing lithologic descriptions of subsurface sediment cores. This report presents the data collected and analyzed by the U.S. Geological Survey from June–September 2014, and the lithologic descriptions of sediment cores collected by the Afghanistan Geological Survey.

In September 2014, six boreholes were drilled in the dry lake surface of Dasht-e-Nawar basin. A total of 406 m of sediment core was collected, along with 44 pore-water samples. The longest core was 109 m, followed by 99 m, 63 m, and three 45 m cores. As of September 2014, pore waters from four of the six boreholes had been analyzed. Major cation concentrations were Na (3–1090 mg/L) > Mg (12.1–243 mg/L) > Ca (7.2–69.8 mg/L) > K (<0.05–59.9 mg/L). Lithium ranged from <50 to186 µg/L and did not show a consistent pattern with sample depth. This range is about three orders of magnitude less than Li concentrations in springs and brines of South America, where Li brines are mined.

Interpretation of the data from the passive seismic survey suggests that the maximum sediment thickness in the northern lobe of the basin is 107 m, and in the southern lobe of the basin it is 173 m. Although the boreholes did not extend to the basin floor, the low Li concentration observed in pore waters does not suggest the presence of a viable Li brine resource at Dasht-e-Nawar.

Introduction

In 2009 the Department of Defense Task Force for Business and Stability Operations (TF in this report) consulted with the U.S. Geological Survey (USGS) and Cathay Oil and Gas (Cathay in this report) on the use of mineral resources for rebuilding rural economies in Afghanistan. Resources for lithium (Li) had been discussed by Peters and others (2007), who noted occurrences of pegmatites,

[1]U.S. Geological Survey.
[2]Afghanistan Geological Survey.

mineralized springs, and dry lake sediments and brines that could be favorable hosts for Li resources. As a result of the further discussions Cathay was awarded a contract to use satellite imagery to explore for Li in nine dry lake basins in Afghanistan (fig. 1). Because Li cannot be detected with satellite imagery, Cathay used boron (B) concentrations as a proxy, due to the close association of Li and B in known Li-bearing brines.

Dasht-e-Nawar was one of the nine dry lake basins studied by Cathay, who noted that its topographic and geological settings are similar to those of dry lake basins in Bolivia and Chile that are resources for B and Li. Based upon their analysis of Landsat and Advanced Spaceborne Thermal Emission and Reflection (ASTER) satellite spectrometry, Cathay created a map of favorable locations for Li-bearing brines in Dasht-e-Nawar, and identified three optimum sampling sites for ground-based exploration (fig. 2). Cathay, USGS, and the TF conducted two sampling trips to Dasht-e-Nawar basin (December 2009 and May–June 2010) to confirm their interpretations of the satellite spectrometry, and to determine the Li content of basin sediments and pore waters. Unfortunately a combination of weather conditions and security concerns prohibited access to their optimum (preferred) sample sites during either trip, but they were able to collect sediment from sites noted in figure 2. These data (table 1) show Li concentrations of 35–77 parts per million (ppm) and B concentrations of 80–110 ppm in surface sediments. Based on these analyses, Cathay recommended additional sample collection at Dasht-e-Nawar, predicting that Li concentrations in the sediments would be higher if samples could be collected from their recommended optimum sampling sites (fig. 2).

In October 2013 Centar American (Centar in this report) submitted a proposal to the TF to continue Li exploration in Afghanistan and collect sub-surface samples of brines and sediments in two dry lake beds. The TF asked USGS to comment on this early proposal, and later asked the USGS to provide additional scientific data, prioritize the potential areas, and advise on sampling methods and analysis. In a February 2014 the USGS reviewed the sediment and pore-water data collected during the Cathay sampling trips, and based on Li concentrations in these samples, recommended continued exploration, in order of priority, at Dasht-e-Nawar, Namaskar-e-Herat, and Godzareh West basins. The optimum borehole locations recommended by Cathay were suggested as sample targets (fig. 2). Additionally, the USGS offered to assist the exploration activities by analyzing the sediment and pore-water samples, by conducting a passive seismic survey of the basin-sediment thickness, and by conducting a downhole geophysical survey of the boreholes. The surveys would complement the geochemical data by providing information on basin depth and the location of brines within the subsurface.

Centar's proposal to the TF was accepted during the spring of 2014, and SRK Consulting (U.S.) Inc. was included in the project to provide geological oversight. The USGS participated in one conference call with all of the partners (Centar, SRK, TF, and Intertek Laboratories—contracted for chemical analysis of samples), and agreed to analyze reconnaissance samples of soil, sediment, and rock for specific gravity. This analysis was necessary for interpretation of the gravity survey which was to be conducted prior to drilling. As plans developed for drilling, it was decided that the USGS could receive splits of brine and core samples; however security concerns would prohibit them from travelling to the Dasht-e-Nawar site to conduct passive seismic and downhole geophysical surveys. Consequently, Centar agreed to collect the passive seismic measurements with USGS guidance, and the boreholes were PVC-cased and capped to allow access for potential downhole geophysical surveys in the future.

The purpose of this report is to present data collected by the USGS in support of Li exploration at Dasht-e-Nawar during June–September, 2014. This report also presents information compiled by this study from earlier investigations, which were otherwise not readily available. This is an interim report because it contains only the data collected from Dasht-e-Nawar through September 30, 2014.

Dasht-e-Nawar

Dasht-e-Nawar is an elliptical basin in the south-west/central Afghan Highlands, measuring 60 km N-S and 30 km E-W, approximately 55 km west of Ghazni. A dry lake playa with an area of 500–600 km^2 and 3,115 m in elevation, occupies the southern part of the basin. The seasonal lake generally begins filling at the time of snowmelt, and recedes due to evaporation during the spring and summer, such that the playa generally is dry by August. Forstner (1973) estimated that the lake contains between 2 and 20 x 10^6 m^3 of water between 0.3–1 m depth, and with shorelines that do not extend to the playa's edge. Thermal springs have been reported, mostly through word-of-mouth, along the western and southeastern edges of the basin (Smith, 1975).

The Dasht-e-Nawar basin has been a focus for exploration for evaporite deposits since the 1970s, when studies by Forstner (1973) and Smith (1975) described the mineralogy and chemistry of its surficial deposits. Smith (1975) notes that young volcanic rocks and thermal springs are common features in closed basins with sodium- and carbonate-rich waters. Both studies described the surface of the basin as containing lacustrine silts and clays, with light gray efflorescent areas. Smith (1975) sampled the efflorescent crusts with the assumption that they had precipitated from interstitial brines drawn to the surface by capillary action. Analysis by X-ray diffraction (XRD) showed the crusts consist of thenardite, Na_2SO_4; halite, NaCl; dolomite, $CaMg(CO_3)_2$; calcite, $CaCO_3$; and clastic minerals such as quartz and feldspar. Smith (1975) estimated that approximately 5 volume percent of the material may be sodium carbonate, likely a mixture of trona ($NaH(CO_3)_2 \cdot 2H_2O$) and nahcolite ($NaHCO_3$). Forstner (1973) collected samples of pore waters from the top 150 cm of the playa surface at Dasht-e-Nawar (table 2). His analyses showed concentrations of $Na^+ > K^+ > Mg^{2+} > Ca^{2+}$, and $Cl^- > HCO_3- + CO_3^{2-} > SO_4^{2-}$.

General Geology

Dasht-e-Nawar is an alluvium-filled basin. The basin probably formed as the result of caldera collapse after the eruption of tuffs and lavas during the Pleistocene. A number of basin-bounding faults have been identified in the report titled "Map and Database of Probable and Possible Quaternary Faults in Afghanistan" by Ruleman and others (2007). These basin-bounding faults are evidence of the collapse structure at Dasht-e-Nawar. The mountain ranges that surround the Dasht-e-Nawar basin reach elevations from 3,500 m to over 4,500 m, with a few peaks to the west exceeding 4,700 m. The mountains to the east and west of the basin are composed primarily of Paleozoic to Mesozoic clastic sedimentary rocks, limestone, and dolomites. These rocks have a strong northeast- to southwest-striking fabric as a result of folding and northeast- to southwest-striking faults (Bohannon, 2007). Many of the units are separated by fault contacts. The sedimentary rocks in the vicinity of Dasht-e-Nawar are primarily siltstone and sandstone, limestone, and dolomite. A few outcrops of older metamorphic rocks are shown in fault contact with the sedimentary rocks, limestone, and dolomite (Bohannon, 2007).

Late Mesozoic to early Cenozoic intrusive igneous rocks are mapped to the south of the Dasht-e-Nawar basin (Bohannon, 2007) intruding the Paleozoic and Mesozoic rocks. Very few of the northeast- to southwest-trending faults are mapped in the intrusive igneous rocks. Pleistocene extrusive volcanic rocks occur on the east and south sides of the basin. These rocks are mapped as andesite tuff and as rhyodacite. The andesite tuffs are part of the Dashtinovar Series (Bohannon, 2007). The andesite tuff is the most extensive unit and covers much of the lower elevations on the east side of the basin. It also forms the hills that border the southern end of the basin. Aerial images suggest that cinder cones or similar volcanic features are present in the hills that form the southern boundary of the basin. Only a few outcrops of rhyodacite are preserved where they overlie the tuff. The only faulting in the extrusive volcanic rocks are basin-bounding faults and a few northeast- to southwest-trending faults (Ruleman and others, 2007).

Unconsolidated sediments and a central shallow-water lake fill the lowest elevations of the basin. Alluvial and colluvial fans lie along the flanks of the mountains, and playa deposits are in the basin bottom (the salar). These playa deposits consist of mud, silt, and clay. Additionally, there are a few isolated outcrops of conglomerate and sandstone overlying, and adjacent to, the andesite tuff. Basin-bounding faults are present at the contact between the alluvial/colluvial fans and the playa deposits, and also at the contact between the volcanic rocks and the unconsolidated sediments (Ruleman and others, 2007).

Dahst-e-Nawar Lake

Landsat imagery from April through October 2014 shows the receding surface area of Dasht-e-Nawar Lake (figs. 3–6). These images include the optimum sample sites from Cathay recommendations and sample locations from the trips to Dasht-e-Nawar made by the USGS and Cathay.

Specific Gravity Measurements

The Reconnaissance Mission 1 (RM1), conducted by Centar during May 24–27, 2014, collected samples of surface material at Dasht-e-Nawar for specific gravity analysis. Specific gravity data were needed for processing and interpretation of the data from the gravity survey conducted by SRK. Seven soil samples and one rock sample were collected by the RM1 team and sent to the USGS for analysis. Soil samples were sent directly to the USGS laboratory in Denver as required by the U.S. Department of Agriculture and U.S. Customs and Border Protection soil import permits. The rock sample was sent directly to the analyst in Reno, Nev. Samples were analyzed with standard procedures (Flint and Flint, 2002) and the specific gravity values ranged from 1.917 to 2.510 (dry weight) for the soils, and was 2.751 for the rock sample (table 3).

Dasht-e-Nawar Drilling

Drilling was conducted by Centar during September 2014, using sonic technology with drilling water from a spring on the west side of the basin (fig. 7). Borehole locations are shown in figure 7 and a summary of borehole information is provided in table 4.

Pore waters were collected with the Push-Ahead groundwater sampling system. The Push-Ahead sampler is sonically driven into the undisturbed sediment to a depth 1.5–4.5 m below the base of the borehole. When the sampler is positioned at the correct location it is opened to allow entry of formation water, which is then collected directly from the drill rod with a bailer (Terrance Cameron, Centar America, written commun., September 2014). Once collected, samples were allowed to sit for a short time to allow sediment to settle, then poured into bottles and capped. Samples were not filtered or acidified in the field, but care was taken to maintain a constant temperature throughout sample handling and shipment.

One sample split of the pore waters was sent to the USGS laboratories in Denver, Colo., and analyzed by inductively coupled plasma mass spectrometry (ICPMS). These data are provided in table 5 and a plot of Li concentrations with depth is shown in figure 8. The headings in Table 5 indicate that ICPMS analysis was performed on a leachate of the water sample (see ICPMS_LEACH headings, table 5). This designation was chosen because the samples, which contained significant dissolved solids, were not digested in order to redissolve any material which may have precipitated out of solution. The "/P" notation following the element symbol (table 5) emphasizes this was a "Partial" analysis and that some elements might have precipitated out because the samples were not filtered and acidified at the time of collection. Currently (October 2014), only boreholes 1 through 4 have been analyzed by the USGS. Results from analysis of the SRK sample split have not been provided to the USGS as of September 30, 2014.

Passive Seismic Investigation

A passive seismic investigation of sediment thickness in the Dasht-e Nawar basin was conducted by the USGS, with field assistance by Centar, between July and September 2014. The passive seismic survey used a portable (hand-held) broadband seismometer (http://www.tromino.it). Field studies have used the method to estimate the thickness of unconsolidated sediments in the 10- to 1000-m range (Ibs-von Seht and Wohlenberg, 1999; Delgado and others, 2000; Parolai and others, 2002; Lane and others, 2008; Haefner and others, 2011).

For this method, the spectral ratio of the horizontal (H) and vertical (V) components of the seismic noise, was processed following guidelines given by the Geospy Project (http://www.geopsy.org/wiki/index.php/Main_Page) to determine the site resonant frequency (f_{r0}). In theory, f_{r0} is a logarithmic function of sediment thickness (Z) following the equation:

$$Z = a f_{r0}^{\,b} \qquad (1)$$

where *the coefficients* a and b are determined empirically for a site or region. There were no depth-to-bedrock measurements in the Dasht-e-Nawar basin for local calibration of the sediment thickness function; therefore, coefficients derived by Lane and others (2008) were used. The error associated with this assumption is not known. The H/V method assumes a contrast in acoustic impedance, a product of material density and seismic velocity, greater than 2 to 1 of the bedrock and overlying sediments (Lane and others, 2008). This method becomes ineffective with a poor contrast in acoustic impedance, as may occur with semi-lithified sediments or weathered bedrock. Surveys may also be negatively affected by poor ground coupling, which commonly occurs with less experienced field personnel, strong wind, and (or) surface crusts. Although the H/V method has been found to be robust in suitable conditions, one investigation notes the possibility of underestimation of sediment thickness in clays (Haefner and others, 2011). The thick clays at Dasht-e-Nawar basin may lead to underestimation of sediment thicknesses by an unknown amount. However, the sediment thickness interpreted for this study, using the passive seismic method and coefficients from Lane and others (2008), were found to be similar to the sediment thickness from an independent gravity survey provided by SRK (James Gilbert, SRK, written commun., 2014).

Two sets of seismic data were collected in the Dasht-e-Nawar basin by Centar (Terrance Cameron, CENTAR American Technical Services, written commun., 2014). In the first survey (from July 29 to August 2), ambient seismic noise was recorded for 20 minutes at a given location and 50 measurements were collected (fig. 9, table 6). In the second survey (from September 20 to 22), ambient seismic noise was recorded for 30 minutes and 28 measurements were collected (fig. 9, table 6). USGS personnel could not be on site to oversee data collection and many of the data, particularly from the second survey, indicate poor ground coupling. It was determined that the first set of measurements were affected by wind noise and possibly poor ground coupling, therefore longer data collection times were used in the second survey in an attempt to overcome these problems. However, data-quality difficulties in the second survey may have been further compounded by less experienced field assistance. More than 80 percent of the measurements in the two surveys were negatively affected by either, or both, strong wind or poor ground coupling. Indications of a surface crust were filtered out of some measurements and some measurements were eliminated where interpreted thicknesses were excessively shallow (less than 20 m) and not representative of the basin bottom thickness.

Table 6 provides the site identifier and location, resonance peak, and the calculated sediment thickness and 95 percent confidence interval. The confidence interval incorporates a measure of width of the resonance peak and does not necessarily reflect the quality of the measurement. A large confidence interval may be caused by a wide resonance peak, such as may occur with a response from multiple surfaces or a sloping surface with considerable topographic relief. Measurements that could not be interpreted, due to noise or poor coupling, were identified in table 6. Sediment thickness was calculated for some sites but the measurement quality was questionable and therefore is not shown on figure 9. Although the quality of many measurements may be poor, a resonance frequency peak could still be identified and interpreted sediment thicknesses were similar to those of the independent gravity survey. Additionally, at the few sites where there were two interpreted sediment thicknesses, from the seismic surveys collected on different dates, the thicknesses were found to be similar in most cases (table 6). For example, at site C04 (fig. 9) thicknesses of 31 and 34 m were calculated, and at site B04 thicknesses of 41 and 37 m were calculated. The surveys indicate a northern and southern lobe of the basin with sediments greater than 100-m thick (fig. 1). The maximum interpreted sediment thickness, using literature empirical coefficients (Lane and others, 2008), was 107 and 173 m in the northern and southern basin lobes, respectively.

Description of Sediment Core (section contributed by the Afghanistan Geological Survey)

Cores obtained during sonic drilling at Dasht-e-Nawar were separated into longitudinal quarters (splits) at the drilling site by Centar geologists and the split described here was provided to the Afghanistan Geological Survey (AGS), through the Ministry of Mines and Petroleum (MoMP). Characteristics of the Dasht-e-Nawar cores were geologically logged by the AGS mapping team between September 21 and 24. The logs completed by the AGS mapping team included (1) a general description of each core, (2) a detailed description of each core that was entered into the AGS core log database (appendix 1), and (3) a photographic log (appendix 2).

Description of Borehole DSN14-SD01 Core

0.0 to 46.0 m there is a sequence of silt and clay with color changes from tan to dark tan and gray.
46.0 to 48.5 m the lithology changes to medium-grained gray colored sand.
48.5 to 51.0 m the lithology changes from medium-grained dark tan colored sand to sandy clay.
51.0 to 73.5 m dark tan to light tan color and locally gray siltstone is present.
73.5 to 75.3 m, medium to coarse-grained gray sand.
75.3 to 77.5 m fine grained sand can be seen in tan color.
77.5 to 79.0 m tan colored sand can be observed.
79.0 to 81.3 m fine grained sand in dark tan color is visible.
81.3 to 84.0 m there is a sequence of fine grained to coarse grained and back to fine grained sand in tan color.
84.0 to 86.0 m clay with the tan to gray color can be observed.
86.0 to 87.0 m fine grained to coarse grained sand is visible in light tan color.
87.0 to 93.0 m clay with change of color from light gray to dark gray can be observed.
93.0 to 94.5 m clay-sand in gray color and from 94.5 up to 96.0 meters is gray colored siltstone.

Description of Borehole DSN14-SD02 Core

0.0 to 15 m all the lithology is clay in tan to gray color; some plant roots at 4–5 m.
15.0 to 21.0 m the lithology changes to silt with a light gray color.
21.0 to 36.0 m clay in tan and light gray. From 36.0 to 38.85 m silt of light gray.
38.85 to 41.7 m clay from gray to light gray, which is because of $CaCO_3$.
41.7 to 42.1 m silt in the same color mentioned above.
42.1 to 58.5 m clay from light gray in the beginning and dark gray at the end, around 49 m some shale fragments can be seen and around 50 m a fossil (?).
58.5 to 60.0 m silt in a very light gray color because of $CaCO_3$.
60.0 to 70.3 m clay in gray to very light gray color, shale fragment and mica.
70.3 to 72.0 m silt in gray color.
72.0 to 88.0 m clay in dark tan in the beginning and gray to dark gray.
88.0 to 90.0 m is silt in light gray.
90.0 to 108.0 m at the beginning the color varies between light gray to dark gray. The bottom of the hole is clay with many small orange to brownish spots.

Description of Borehole DSN14-SD03 Core

0.0 to 15.0 m clay in dark gray color. No core recovered from 9-12 meters.
15.0 to 24.0 m lithology changes from clay to silt in light gray color, with many laminations of clay with black spots within the silt.
24.0 to 29.7 m clay in dark gray color. Some small dark colored spots that smell sulfurous observed around 29.5 m.
29.7 to 63.0 m silt varying between dark gray to light gray. Plant roots appear at 31.5and 50.8 m. At 41.8 m the color changes to very light gray to white. No core recovered from 51.0 to 54.0 m.
63.0 to 66.0 m clay in dark gray at the beginning changing to light gray at the end.

Description of Borehole DSN14-SD04 Core

0.0 to 1.90 m the lithology is very fine grained sand in light gray color.
1.90 to 2.60 m is silt in light gray.
2.60 to 3.0 m is clay in gray color.
3.0 to 7.9 m is very fine grained sand mixed with clay (sandy clay) in dark gray at the beginning and tan at the end.
7.9 to 9.0 m is silt in light gray color.
9.0 to 11.9 m is very fine grained sand in light gray changing to tan at the very end.
11.9 to 14.0 m is medium grained sand in tan.
14.0 to 17.6 m silt in tan.
17.6 to 18.0 m is sand in tan.
18.0 to 20.4 m is clay in dark gray and tan at the end.
20.4 to 20.8 m is very fine grained sand in tan.
20.8 to 21.0 m is silt in tan.
21.0 to 23.9 m is very fine grained sand in dark gray with small laminations of silt.
23.9 to 24.0 m is a tiny layer of sand in tan. No core was recovered from 24.0 to 27.0 m.
27.0 to 28.9 m is clay in tan.
28.9 to 30.0 m is very fine grained sand mixed with clay in tan.
30.0 to 33.0 m is sand mixed with clay (sandy clay) in dark gray.

33.0 to 33.6 m is silt in tan.
33.6 to 36.0 m is medium size conglomerate in light tan.
36.0 to 41.0 m is very fine grained sand in tan.
41.0 to 41.8 m is fine grained sand with coarser grains.
41.8 to 45.1 m is fine grained sand in tan.

Description of Borehole DSN14-SD05 Core

0.0 to 6.0 m is a sequence of small laminations of silt and clay tan.
6.0 to 7.4 m is clay in light gray.
7.4 to 9.1 m is silt in tan.
9.1 to 9.8 m is clay in dark gray.
9.8 to 10.1 m is silt in dark gray.
10.1 to 10.9 m is clay in dark gray.
13.4 to 16.3 m is clay and the color changes from dark gray at the beginning to light gray at the end.
16.3 up to 18.0 m is silt in light gray.
18.0 to 18.9 m is clay in tan.
18.9 up to 24.6 m is silt in light gray and at 20.3 there is dark material with a sulfurous smell.
24.6 to 28.0 m is clay in dark grey.
28.0 to 31.1 m is silt in dark gray.
32.5 to 45.0 m is silt in tan at the very beginning and dark gray to gray to the end.

Description of Borehole DSN14-SD06 Core

0.0 to 3.0 m no core recovered.
3.0 to 15.0 m is clay in dark gray mixed with brown colored material up to 6.0 m.
15.0 to 24.1 m is silt from dark gray to light gray at the end.
24.1 to 25.4 m is clay in dark tan.
25.4 to 27.0 m is silt and the color changes from dark tan at the beginning and gray at the end.
27.0 to 36.1 m is clay in dark gray and some black spots are visible at the beginning of the section and the entire section has a sulfurous smell.
36.1 to 45.0 m is silt in dark gray at the beginning and light gray at the end.

Summary

In September 2014, six boreholes were drilled in the dry lake basin of Dasht-e-Nawar, Afghanistan (DSN14-SD01-06). A total of 406 m of sediment core were collected along with 44 samples of pore water. This report contains chemical analyses of pore waters from boreholes at site DSN14-SD01-04, and a description of the sediment cores provided by the Afghanistan Geological Survey. Additional data include Landsat images of the Dasht-e-Nawar Lake from April to September 2014, and results of a passive seismic survey conducted by Centar personnel with USGS equipment. USGS personnel performed the data reduction needed to calculate sediment thickness and assess data quality from the seismic survey. Although the seismic data was of poor quality, the passive seismic method was found to be successful for determining basin sediment thickness. The maximum interpreted thicknesses in the basin were found to be 107 m in the northern basin lobe and 173 m in the southern lobe.

The pore water chemistry collected in September 2014 (table 5) is quite different from that collected in 1969 by Forstner (1973; table 2). In 1969, the major cation concentrations were Na^+ (482–

3410 ppm) > K^+ (110–208 ppm) >Mg^{2+} (31.2–82.9 ppm) > Ca^{2+} (1.2–9.7 ppm). In 2014, the major cation concentrations were Na^+ (3–1090 mg/L) > Mg^{2+} (12.1–243 mg/L) > Ca^{2+} (7.2–69.8 mg/L) > K^+ (<0.05–59.9 mg/L). Lithium (Li^+) concentration in the pore waters collected in 2014 ranged from <50–186 µg/L and did not show a consistent pattern with sample depth (fig. 8). This concentration range is three orders of magnitude less than the Li concentration of springs and brines in South America, where Li is mined (~3–1500 mg/L Li; Garrett, 2004). At this point the data have not been analyzed to determine whether drilling water may have diluted the pore-water samples. Lithium concentration in the sediments is not available as of the date of this report (October, 2014).

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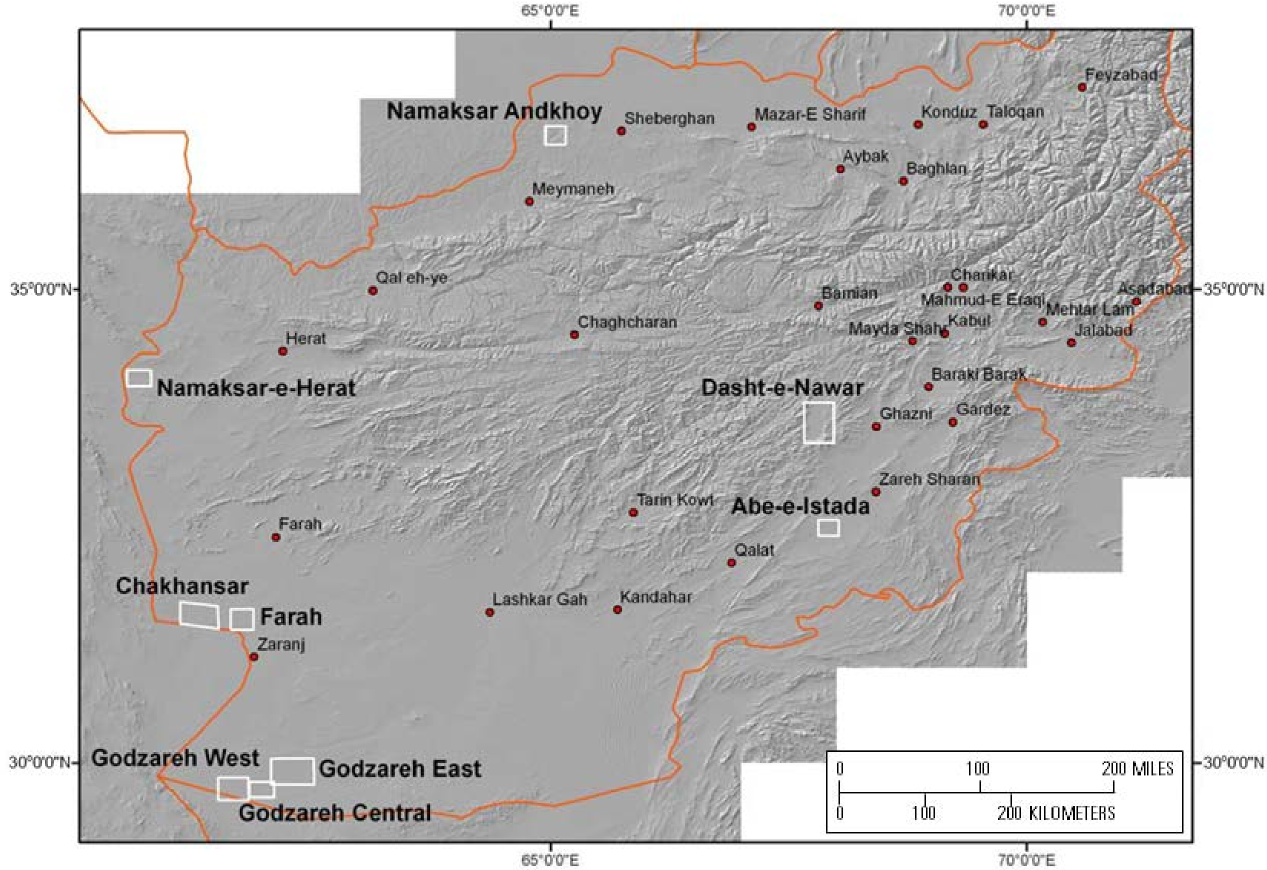


Figure 1. Nine dry lakes (white boxes) considered by Cathay Oil and Gas, Ltd. (written commun., March 22, 2010) in their initial report to the Department of Defense Task Force for Business and Stability Operations.

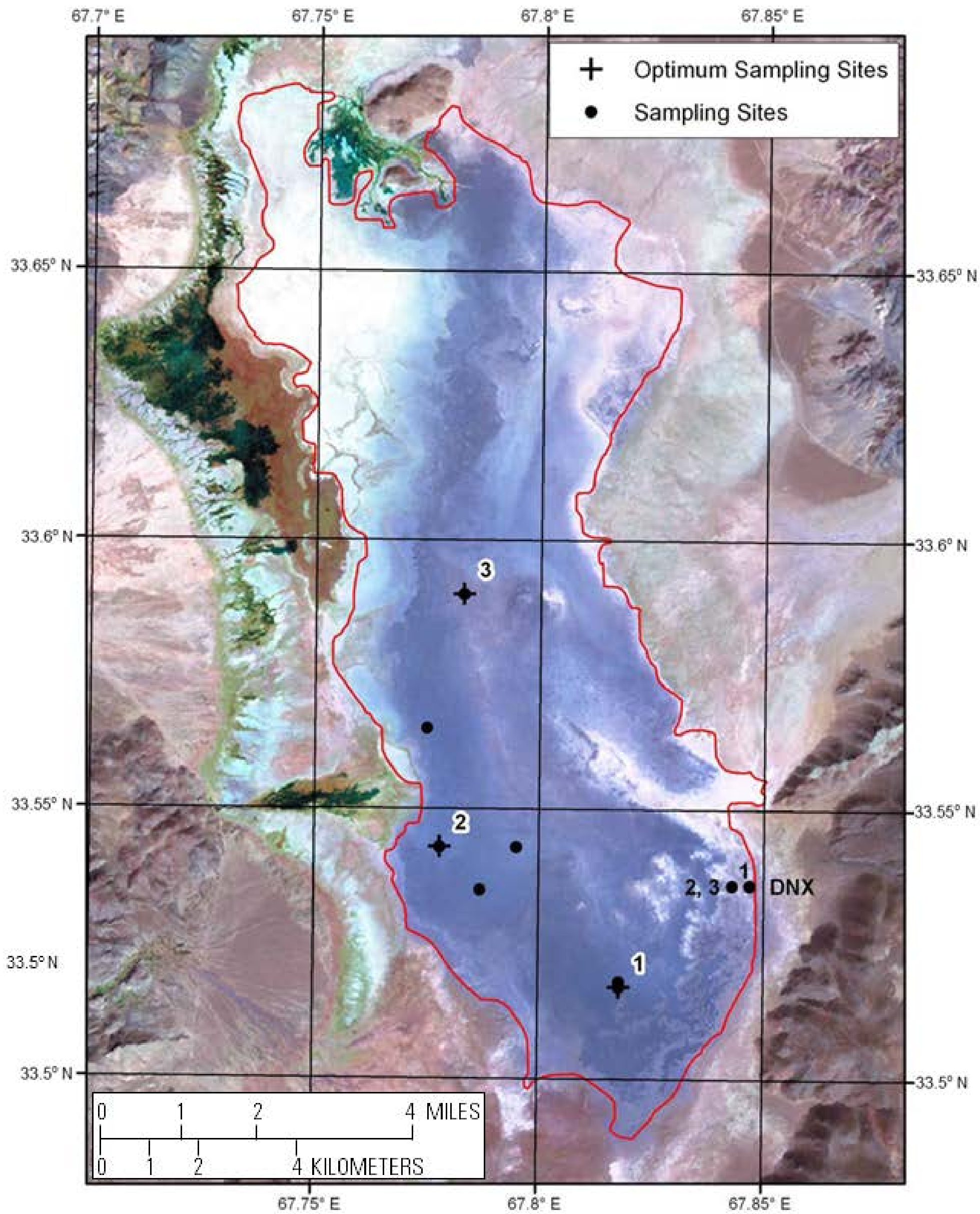


Figure 2. Optimum borehole sample sites for lithium exploration, figure adapted from Cathay Oil and Gas, Ltd. (written commun., March 22, 2010). Also included are sample sites DNX1 and DNX2/3, that were visited in December 2009.

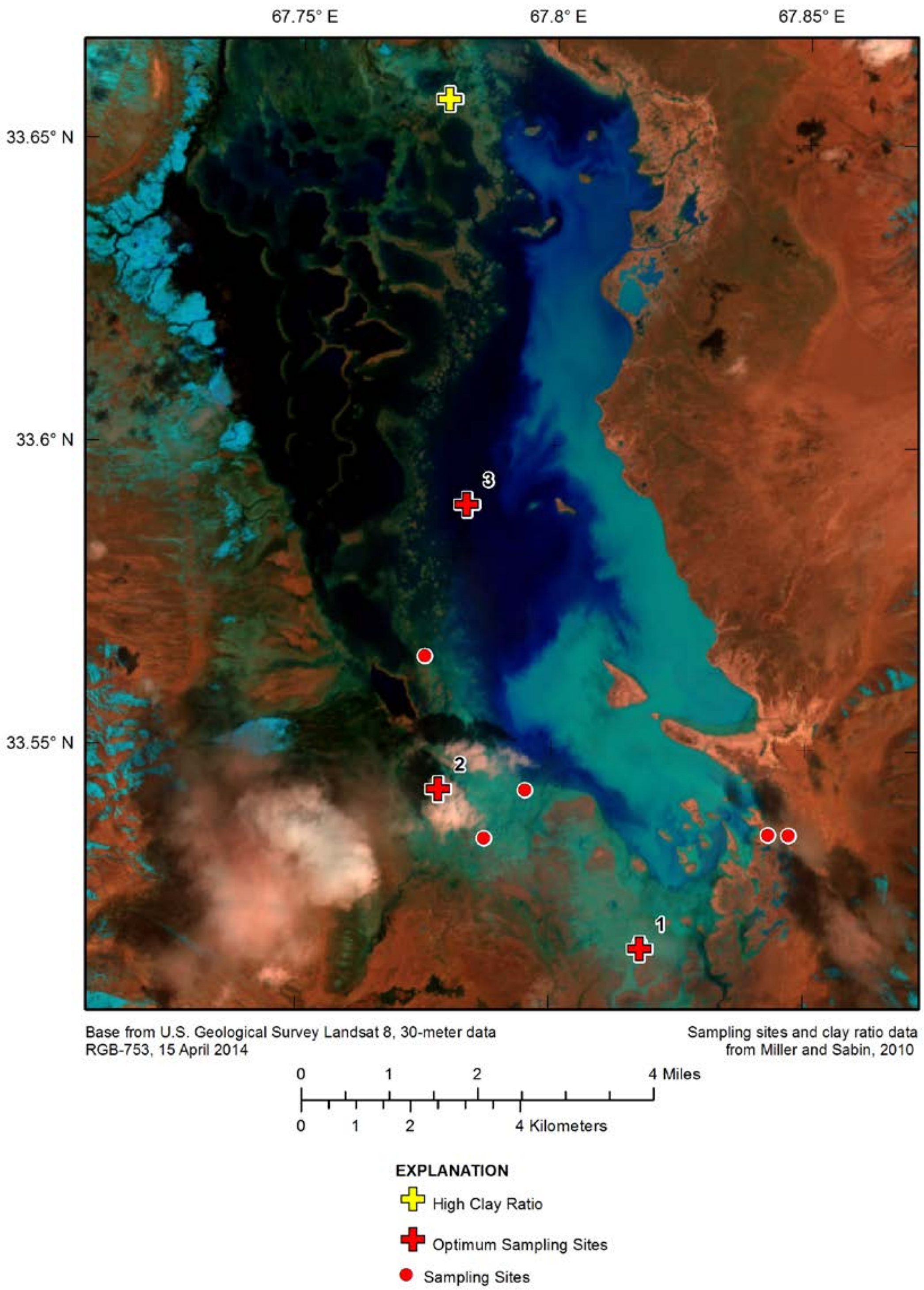


Figure 3. April 15, 2014, Landsat 8 image (RGB-753) of the Dasht-e-Nawar showing the recommended lithium sampling locations from Cathay Oil and Gas, Ltd. (written commun., March 22, 2010).

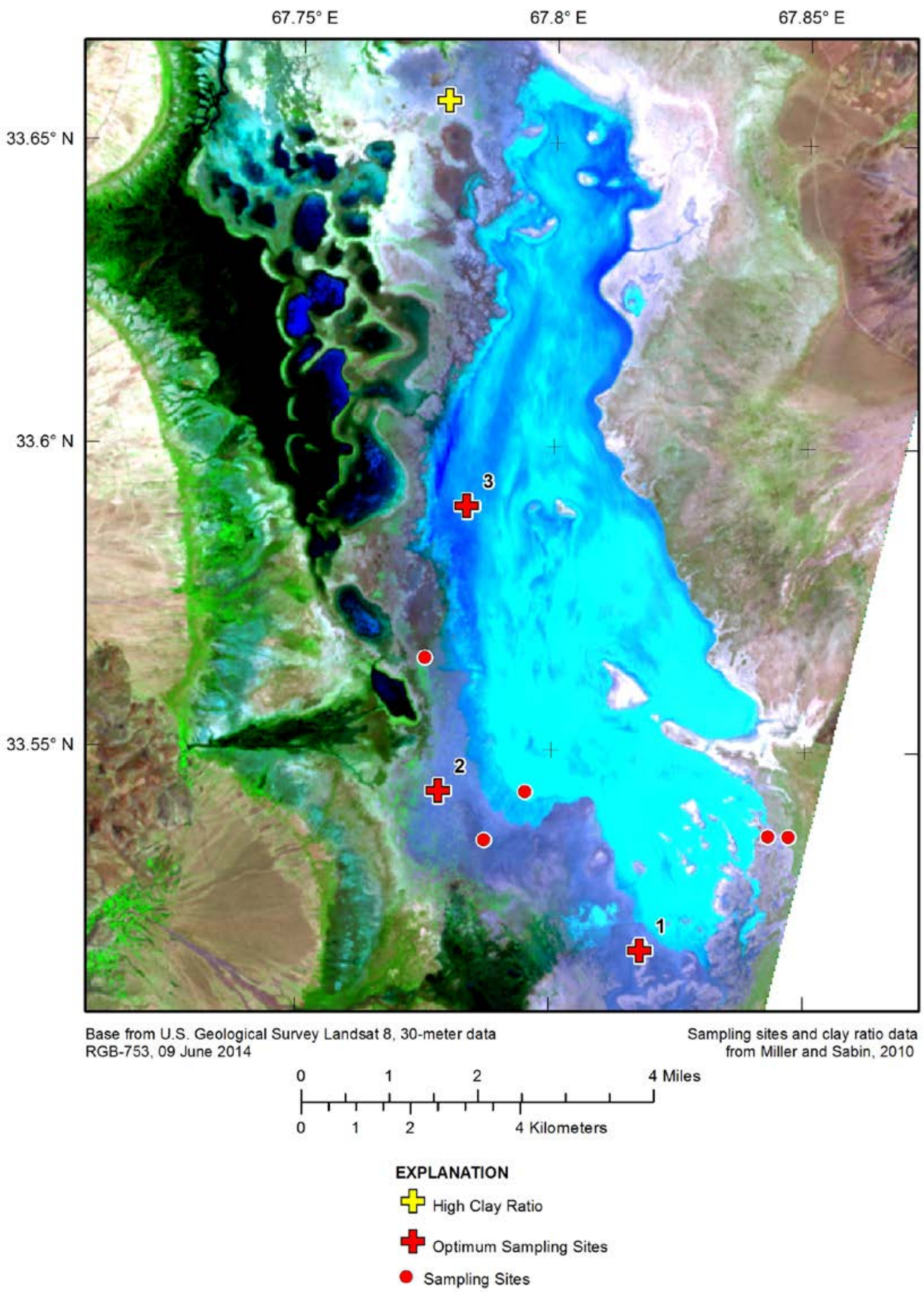


Figure 4. June 09, 2014, Landsat 8 image (RGB-753) of the Dasht-e-Nawar showing the recommended lithium sampling locations from Cathay Oil and Gas, Ltd. (written commun., March 22, 2010).

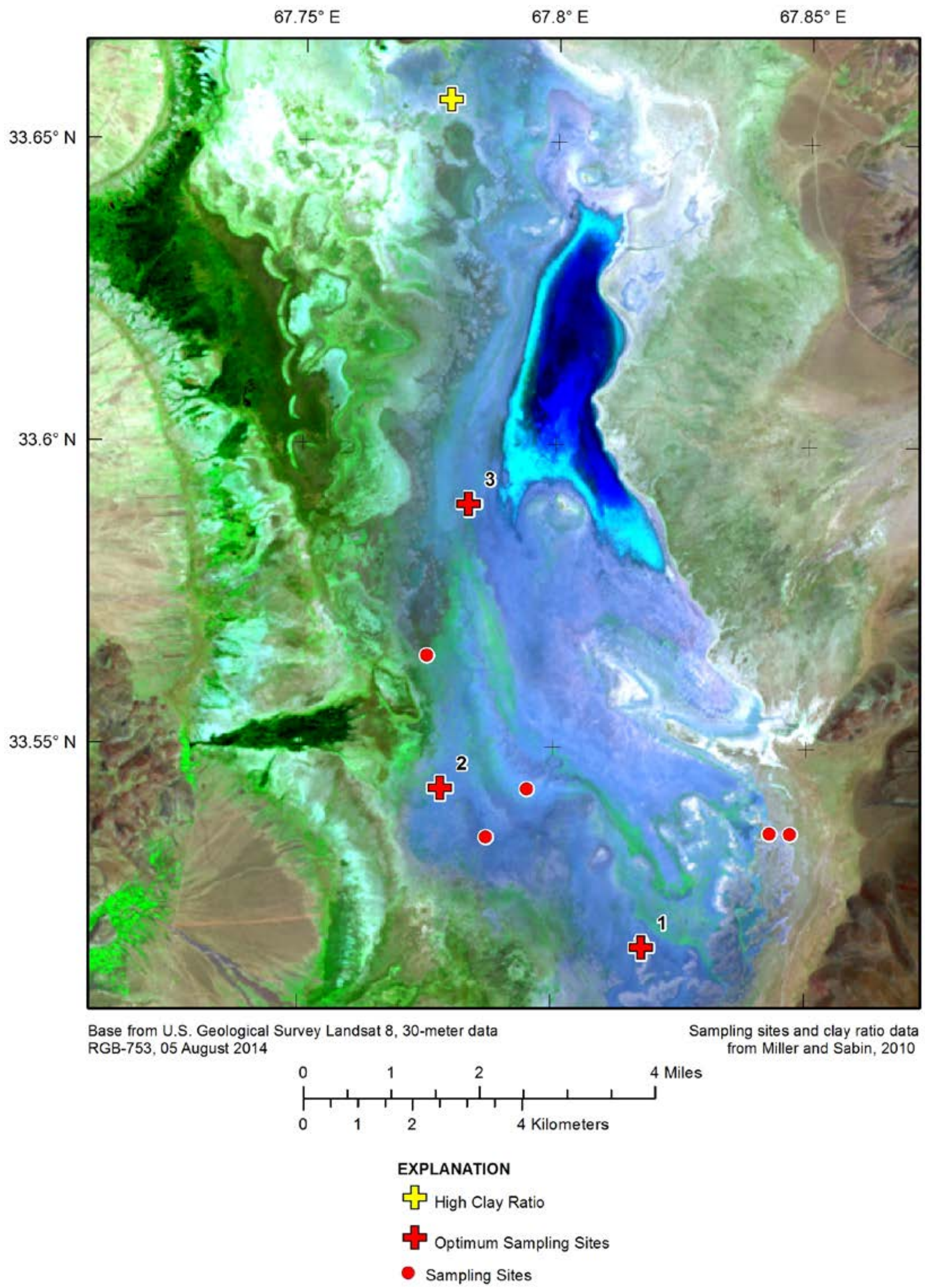


Figure 5. August 05, 2014, Landsat 8 image (RGB-753) of the Dasht-e-Nawar showing the recommended lithium sampling locations from Cathay Oil and Gas, Ltd. (written commun., March 22, 2010).

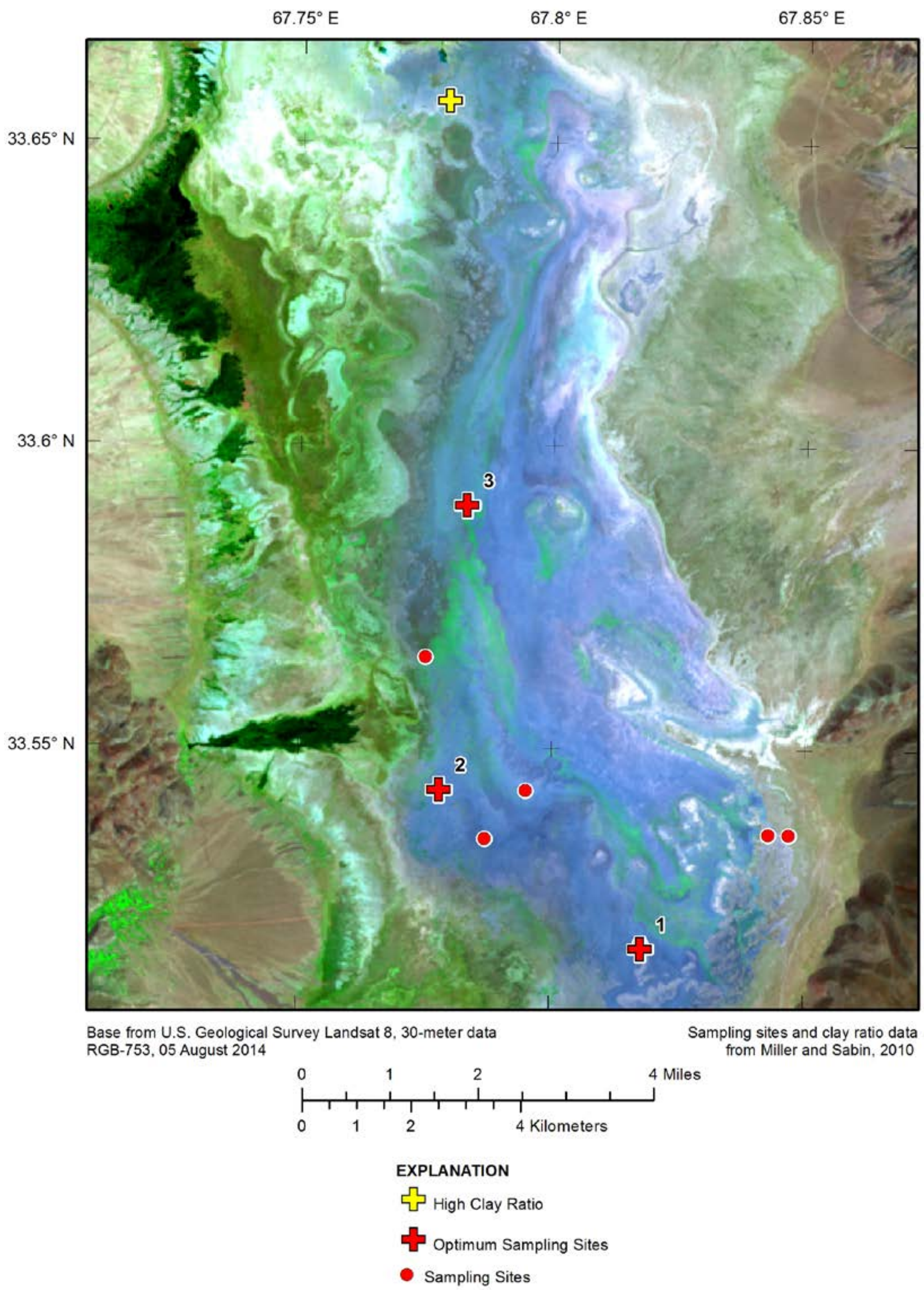


Figure 6. September 06, 2014, Landsat 8 image (RGB-753) of the Dasht-e-Nawar showing the recommended lithium sampling locations from Cathay Oil and Gas, Ltd. (written commun., March 22, 2010).

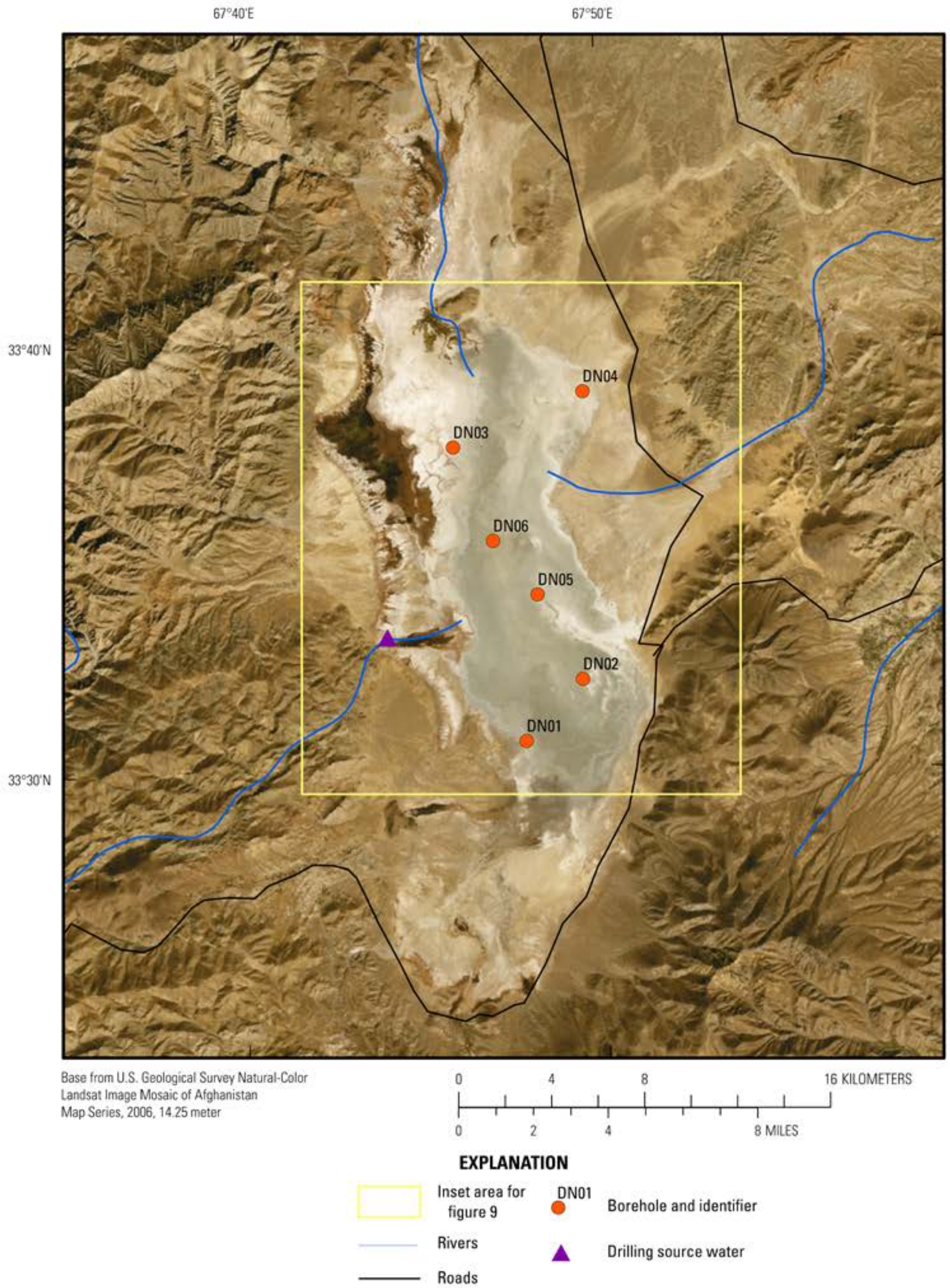


Figure 7. Borehole locations for the September 2014 lithium exploration effort and inset area for figure 9.

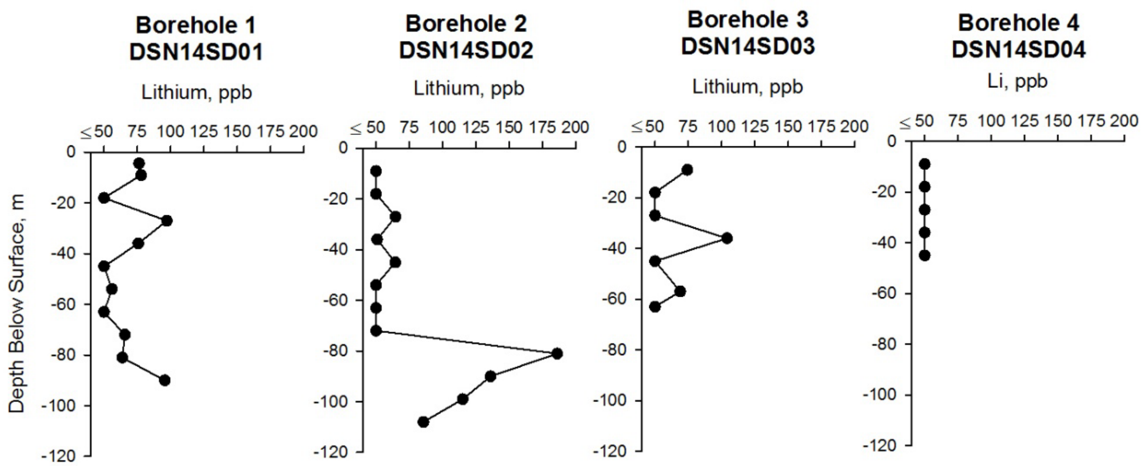


Figure 8. Lithium concentrations in boreholes 1–4 (DSN14SD01-04) at Dasht-e-Nawar. Ppb, parts per billion; m, depth.

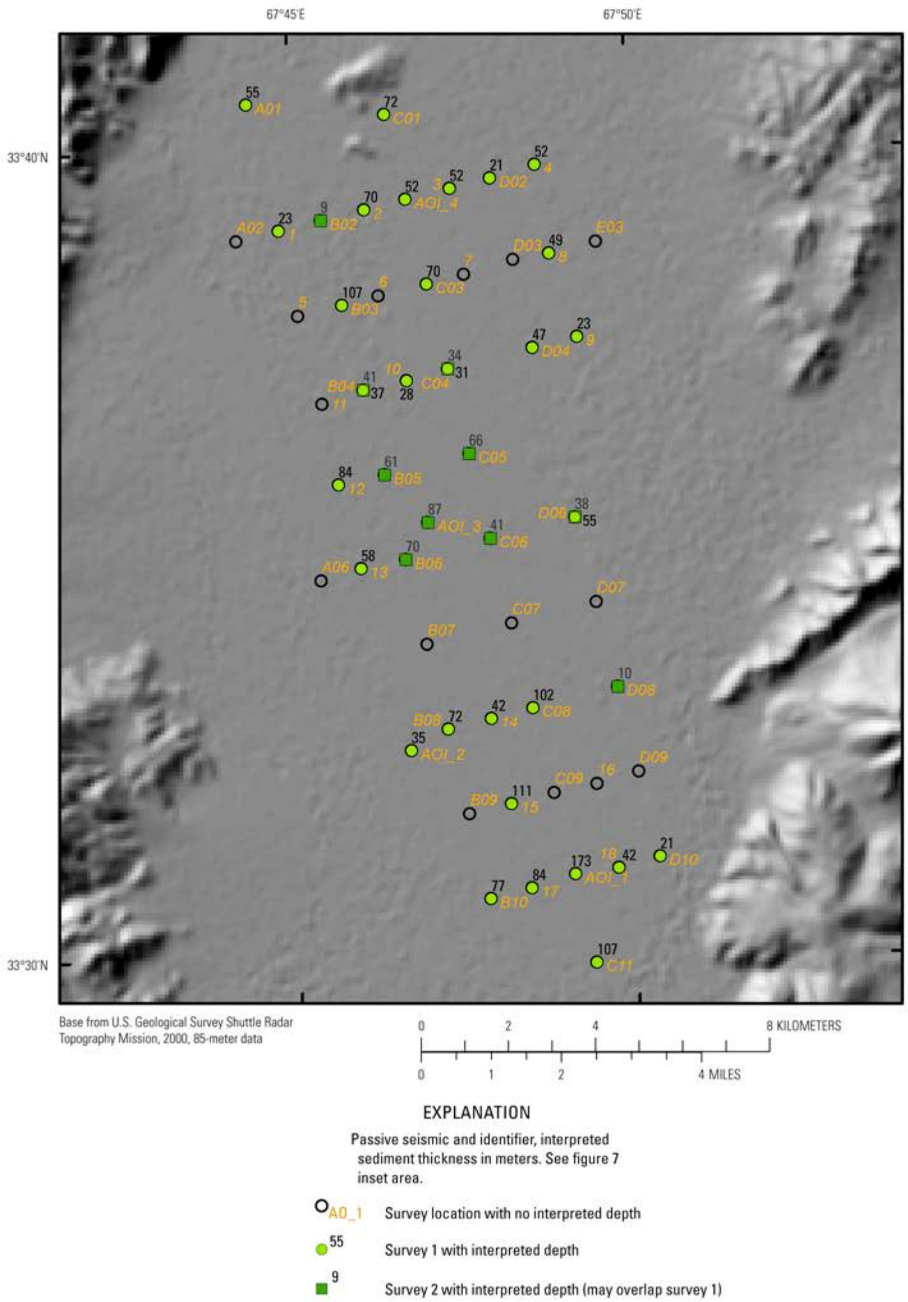


Figure 9. Passive seismic survey data collection points and preliminary sediment thicknesses in Dasht-e-Nawar basin, Afghanistan, July and August, 2014.

Table 1. Li and B concentrations, in parts per million (ppm), in surface sediment samples collected from Dasht-e-Nawar in Afghanistan. December 2009 samples were analyzed by SGS North America Inc. laboratories in Denver, Colo., and the 2010 data were analyzed by the U.S. Geological Survey (data from Cathay Oil and Gas, Ltd., written commun. March 22, 2010, and September, 1, 2010).

[ICPAES_MS 42, inductively coupled plasma atomic emission spectroscopy and mass spectroscopy 42 element package]

Sample date	Field number	USGS lab number	Sample name	Latitude	Longitude	ICPAES_MS 42 Li, ppm	SGS analysis Li, ppm	SGS analysis B, ppm
December 2009			DNX2				55	110
			DNX3				35	80
May–June 2010	COG 0005	343094	DEN-3A	33.58972	67.78204	67.2		
	COG 0006	342584	DEN-3B	33.58972	67.78252	77		
	COG 0006	342589	DEN-3B	33.58972	67.78252	76		
	COG 0007	342581	DEN-3C	33.58972	67.78252	73		
	COG 0008	342582	DEN-3D	33.59002	67.78204	75		
	COG 0008D	342583	DEN-3D	33.58972	67.78252	76		

Table 2. Pore water chemistry (in ppm) from the top 150 cm of the Dasht-e-Nawar playa surface. Samples were collected in 1969 (from Forstner, 1973).

Date	HCO_3^-	CO_3^{2-}	SO_4^{2-}	Cl^-	Mg^{2+}	Ca^{2+}	Na^+	K^+	SiO_2
June (min)	260	24	252	335	31.2	9.7	482	110	26.3
June (max)	745	29	312	452	40.2	5.8	616	134	21.3
September	1320	835	1058	1565	72.8	3.9	1870	194	21.4
October	2620	1520	1765	2914	82.9	1.2	3410	208	23.6

Table 3. Specific gravity of samples collected during Reconnaissance Mission 1 (RM1), May 2014. Coordinates for sample location and elevation were collected by RM1 personnel with a handheld global positioning system. Note that two of the soil samples were not received at the CMERSC Analytical Chemistry Laboratory.
[m, meter; wt, weight]

Sample number	Sample date	Latitude	Longitude	Elevation (m)	Sample type	Specific gravity (dry wt)	Specific gravity (wet, as received)
RM1-1	5/25/2014	33.455944	67.798764	3,138.98	Soil	2.510	2.142
RM1-2	5/26/2014	33.519354	67.838255	3,134.33	Soil	Not received	
RM1-3	5/26/2014	33.519581	67.838489	3,135.42	Soil	2.215	1.998
RM1-4	5/26/2014	33.520926	67.840517	3,135.76	Soil	2.106	1.856
Lab duplicate						1.947	1.739
RM1-5	5/26/2014	22.55397	67.837501	3,135.62	Soil	Not received	
RM1-6	5/26/2014	33.553853	67.840368	3,135.24	Soil	1.917	1.751
RM1-7	5/26/2014	33.59499	67.836789	3,136.35	Soil	2.135	1.892
RM1-8	5/26/2014	33.553191	67.869277	3,172.77	Rock	2.751	--

Table 4. Borehole and drilling characteristics, Dasht-e-Nawar, Afghanistan.
[GPS, global positioning system; m, meters; L, liters; --, not recorded]

Identifier	Latitude, in degrees	Longitude, in degrees	Elevation, in m from handheld GPS	Depth drilled, in m	Number of water samples collected	Drilling water used, in L
DSN14SD01	33.512159	67.797007	--	96	15	10,700
DSN14SD02	33.535891	67.823602	3118	108	12	6,000
DSN14SD03	33.626357	67.765171	3080	66	7	5,500
DSN14SD04	33.647373	67.825636	3125	45	5	1,000
DSN14SD05	33.568912	67.803267	3137	45	5	1,000
DSN14SD06	33.589918	67.782998	3130	45	5	1,000

Table 5. Chemical analysis of pore waters collected from boreholes 1-4 (DSN14SD01–04) by inductively coupled plasma mass spectrometry (ICPMS).
[ICPMS-LEACH and /P notation explained in text, Dasht-e-Nawar drilling section; ug/L, micrograms per liter]

Field no.	Sample description/ Sample depth, m	Borehole no.	Lab no.	Job no.	ICPMS_LEACH Ag/P ug/L	ICPMS_LEACH Al/P ug/L	ICPMS_LEACH As/P ug/L	ICPMS_LEACH B/P ug/L
1	Drilling water	DSN14SD01	C-391087	MRP-14154	<0.2	23.9	<1	17.1
2	4.40	DSN14SD01	C-391088	MRP-14154	<0.2	85.7	1.3	236
3	9.00	DSN14SD01	C-391089	MRP-14154	<0.2	46.8	2.5	163
4	18.00	DSN14SD01	C-391090	MRP-14154	<0.2	17.6	<1	77.6
5	Standard	DSN14SD01	C-391091	MRP-14154	<2	128	<10	<100
6	27.00	DSN14SD01	C-391092	MRP-14154	<0.2	41.9	1.8	93
7	36.00	DSN14SD01	C-391093	MRP-14154	0.267	34.6	17.5	105
8	45.00	DSN14SD01	C-391094	MRP-14154	<0.2	8	8	71.6
9	54.00	DSN14SD01	C-391095	MRP-14154	<0.2	8.7	7.7	72.3
10	63.00	DSN14SD01	C-391096	MRP-14154	<0.2	6.1	1.1	78.2
11	Duplicate of no. 10	DSN14SD01	C-391097	MRP-14154	<0.2	7	1	193
12	72.00	DSN14SD01	C-391098	MRP-14154	<0.2	8.6	3.1	83.9
13	Field blank	DSN14SD01	C-391099	MRP-14154	<0.2	5.8	<1	<10
14	Trip blank	DSN14SD01	C-391100	MRP-14154	<0.2	<5	<1	<10
15	81.00	DSN14SD01	C-391101	MRP-14155	<0.2	8.9	2.8	56.4
16	90.00	DSN14SD01	C-391102	MRP-14155	<0.2	14.3	<1	72.2
17	9.00	DSN14SD02	C-391103	MRP-14155	<0.2	13.1	<1	68.9
18	18.00	DSN14SD02	C-391104	MRP-14155	<0.2	7.7	10.8	125
19	27.00	DSN14SD02	C-391105	MRP-14155	<0.2	10.3	2.1	108
20	Duplicate of no. 19	DSN14SD02	C-391106	MRP-14155	<0.2	8.8	2.2	106
21	36.00	DSN14SD02	C-391107	MRP-14155	<0.2	11.4	<1	52.7
22	45.00	DSN14SD02	C-391108	MRP-14155	<0.2	6.4	<1	55.3
23	Standard	DSN14SD02	C-391109	MRP-14155	<20	1,670	<100	963,000
24	54.00	DSN14SD02	C-391110	MRP-14155	<0.2	34.9	4.6	167
25	63.00	DSN14SD02	C-391111	MRP-14155	<0.2	11.5	1.4	65.8
26	72.00	DSN14SD02	C-391112	MRP-14155	<0.2	23.6	<1	55.6
27	81.00	DSN14SD02	C-391113	MRP-14155	0.222	10.3	14.2	1,560
28	90.00	DSN14SD02	C-391114	MRP-14155	<0.2	10.4	67.9	1,230
29	99.00	DSN14SD02	C-391115	MRP-14155	<0.2	6.5	23.1	940
30	Field blank	DSN14SD02	C-391116	MRP-14155	<0.2	8.4	<1	67.5

Field no.	Sample description/ Sample depth, m	Borehole no.	Lab no.	Job no.	ICPMS_LEACH Ag/P ug/L	ICPMS_LEACH Al/P ug/L	ICPMS_LEACH As/P ug/L	ICPMS_LEACH B/P ug/L
31	Trip blank	DSN14SD02	C-391117	MRP-14155	<0.2	11.8	<1	54.9
32	108.00	DSN14SD02	C-391118	MRP-14156	<0.2	8.5	1.2	302
33	Drilling water	DSN14SD03	C-391119	MRP-14156	<0.2	11.7	<1	55.8
34	9.00	DSN14SD03	C-391120	MRP-14156	<0.2	11.9	1.6	93.7
35	18.00	DSN14SD03	C-391121	MRP-14156	<0.2	14	2.8	93.8
36	27.00	DSN14SD03	C-391122	MRP-14156	<0.2	15.8	1.4	80
37	Duplicate of no. 36	DSN14SD03	C-391123	MRP-14156	<0.2	13.2	1.2	81.1
38	36.00	DSN14SD03	C-391124	MRP-14156	<0.2	33.4	1.3	151
39	45.00	DSN14SD03	C-391125	MRP-14156	<0.2	365	2.3	117
40	57.00	DSN14SD03	C-391126	MRP-14156	<0.2	36.8	30.5	849
41	Standard	DSN14SD03	C-391127	MRP-14156	<0.2	24.8	<1	4,370
42	63.00	DSN14SD03	C-391128	MRP-14156	<0.2	16.5	2.5	109
43	9.00	DSN14SD04	C-391129	MRP-14156	<0.2	10.3	<1	43.4
44	18.00	DSN14SD04	C-391130	MRP-14156	<0.2	8.2	1.1	45.7
45	27.00	DSN14SD04	C-391131	MRP-14156	<0.2	8.4	1.9	38.9
46	36.00	DSN14SD04	C-391132	MRP-14156	<0.2	9.7	<1	25.6
47	45.00	DSN14SD04	C-391133	MRP-14156	<0.2	10	<1	21.5
48	Field blank	DSN14SD04	C-391134	MRP-14156	<0.2	5.8	<1	<10
49	Trip blank	DSN14SD04	C-391135	MRP-14156	<0.2	23.2	<1	<10

Field no.	Sample description/Sample depth, m	Borehole no.	ICPMS_LEACH Ba/P ug/L	ICPMS_LEACH Be/P ug/L	ICPMS_LEACH Bi/P ug/L	ICPMS_LEACH Ca/P mg/L	ICPMS_LEACH Cd/P ug/L	ICPMS_LEACH Ce/P ug/L
1	Drilling water	DSN14SD01	7.4	<1	< 0.2	27.4	<1	< 0.1
2	4.40	DSN14SD01	36.4	1.5	< 0.2	67.2	<1	< 0.1
3	9.00	DSN14SD01	30.8	<1	< 0.2	69.8	<1	< 0.1
4	18.00	DSN14SD01	34.9	<1	< 0.2	58	<1	< 0.1
5	Standard	DSN14SD01	<10	<10	3.13	<2	<10	< 1
6	27.00	DSN14SD01	24	<1	< 0.2	56.8	<1	0.14
7	36.00	DSN14SD01	95.2	<1	0.36	25.7	<1	< 0.1
8	45.00	DSN14SD01	130	<1	0.5	41.5	<1	< 0.1
9	54.00	DSN14SD01	160	<1	0.36	38.2	<1	< 0.1
10	63.00	DSN14SD01	109	<1	0.24	58.3	<1	< 0.1
11	Duplicate of no. 10	DSN14SD01	106	<1	< 0.2	59.8	<1	< 0.1
12	72.00	DSN14SD01	273	<1	< 0.2	35.9	<1	< 0.1
13	Field blank	DSN14SD01	<1	<1	< 0.2	1.3	<1	< 0.1
14	Trip blank	DSN14SD01	<1	<1	< 0.2	<0.2	<1	< 0.1
15	81.00	DSN14SD01	194	<1	< 0.2	35.1	<1	< 0.1
16	90.00	DSN14SD01	118	<1	< 0.2	60.7	<1	< 0.1
17	9.00	DSN14SD02	78.7	<1	< 0.2	63.3	<1	< 0.1
18	18.00	DSN14SD02	83.2	<1	< 0.2	51.5	<1	< 0.1
19	27.00	DSN14SD02	81.2	<1	< 0.2	62.3	<1	< 0.1
20	Duplicate of no. 19	DSN14SD02	83	<1	< 0.2	63.9	<1	< 0.1
21	36.00	DSN14SD02	78.4	<1	< 0.2	67.6	<1	< 0.1
22	45.00	DSN14SD02	81.4	<1	< 0.2	66	<1	< 0.1
23	Standard	DSN14SD02	820	<100	< 20	<20	<100	< 10
24	54.00	DSN14SD02	76.4	<1	0.67	57.4	<1	< 0.1
25	63.00	DSN14SD02	132	<1	0.38	54.9	<1	< 0.1
26	72.00	DSN14SD02	108	<1	0.27	64.3	<1	< 0.1
27	81.00	DSN14SD02	79	<1	0.28	38.1	<1	< 0.1
28	90.00	DSN14SD02	44.2	<1	< 0.2	7.2	<1	< 0.1
29	99.00	DSN14SD02	83.1	<1	< 0.2	30.1	<1	< 0.1
30	Field blank	DSN14SD02	4.1	<1	< 0.2	5	<1	< 0.1
31	Trip blank	DSN14SD02	<1	<1	< 0.2	<0.2	<1	< 0.1
32	108.00	DSN14SD02	117	<1	< 0.2	42.5	<1	< 0.1
33	Drilling water	DSN14SD03	82.8	<1	< 0.2	61.6	<1	< 0.1

Field no.	Sample description/Sample depth, m	Borehole no.	ICPMS_LEACH Ba/P ug/L	ICPMS_LEACH Be/P ug/L	ICPMS_LEACH Bi/P ug/L	ICPMS_LEACH Ca/P mg/L	ICPMS_LEACH Cd/P ug/L	ICPMS_LEACH Ce/P ug/L
34	9.00	DSN14SD03	45.8	<1	< 0.2	52.6	<1	< 0.1
35	18.00	DSN14SD03	95.8	<1	< 0.2	48.9	<1	< 0.1
36	27.00	DSN14SD03	60.2	<1	< 0.2	60.3	<1	< 0.1
37	Duplicate of no. 36	DSN14SD03	59.2	<1	< 0.2	59.8	<1	< 0.1
38	36.00	DSN14SD03	49.8	<1	< 0.2	21.7	<1	0.14
39	45.00	DSN14SD03	84.4	<1	< 0.2	44.2	<1	0.11
40	57.00	DSN14SD03	85	<1	< 0.2	15	<1	< 0.1
41	Standard	DSN14SD03	6.6	<1	< 0.2	0.62	<1	< 0.1
42	63.00	DSN14SD03	106	<1	0.76	32.3	<1	< 0.1
43	9.00	DSN14SD04	95.9	<1	0.4	52.7	<1	< 0.1
44	18.00	DSN14SD04	157	<1	0.32	55.5	<1	< 0.1
45	27.00	DSN14SD04	278	<1	0.21	58.2	<1	< 0.1
46	36.00	DSN14SD04	57.9	<1	< 0.2	37.9	<1	< 0.1
47	45.00	DSN14SD04	109	<1	< 0.2	34.7	<1	< 0.1
48	Field blank	DSN14SD04	<1	<1	< 0.2	0.68	<1	< 0.1
49	Trip blank	DSN14SD04	<1	<1	< 0.2	<0.2	<1	< 0.1

Field no.	Sample description/Sample depth, m	Borehole no.	ICPMS_LEACH Co/P ug/L	ICPMS_LEACH Cr/P ug/L	ICPMS_LEACH Cs/P ug/L	ICPMS_LEACH Cu/P ug/L	ICPMS_LEACH Dy/P ug/L	ICPMS_LEACH Er/P ug/L
1	Drilling water	DSN14SD01	<1	2.4	< 0.5	1.6	< 1	< 0.1
2	4.40	DSN14SD01	1.1	5.9	< 0.5	5.1	< 1	< 0.1
3	9.00	DSN14SD01	<1	8.9	< 0.5	4.9	< 1	< 0.1
4	18.00	DSN14SD01	<1	8.4	< 0.5	3.1	< 1	< 0.1
5	Standard	DSN14SD01	<10	<20	< 5	<10	< 10	< 1
6	27.00	DSN14SD01	<1	7.6	< 0.5	10.7	< 1	< 0.1
7	36.00	DSN14SD01	<1	5.2	< 0.5	<1	< 1	< 0.1
8	45.00	DSN14SD01	<1	7	< 0.5	2.2	< 1	< 0.1
9	54.00	DSN14SD01	<1	5.6	< 0.5	1.7	< 1	< 0.1
10	63.00	DSN14SD01	<1	6.5	< 0.5	3.7	< 1	< 0.1
11	Duplicate of no. 10	DSN14SD01	<1	5.6	< 0.5	3.9	< 1	< 0.1
12	72.00	DSN14SD01	<1	6.9	< 0.5	1.7	< 1	< 0.1
13	Field blank	DSN14SD01	<1	<2	< 0.5	<1	< 1	< 0.1
14	Trip blank	DSN14SD01	<1	<2	< 0.5	<1	< 1	< 0.1
15	81.00	DSN14SD01	<1	9.6	< 0.5	1.5	< 1	< 0.1
16	90.00	DSN14SD01	<1	8.1	< 0.5	2.9	< 1	< 0.1
17	9.00	DSN14SD02	<1	9.2	< 0.5	2.5	< 1	< 0.1
18	18.00	DSN14SD02	<1	8	< 0.5	1.6	< 1	< 0.1
19	27.00	DSN14SD02	<1	10.8	< 0.5	2.2	< 1	< 0.1
20	Duplicate of no. 19	DSN14SD02	<1	12	< 0.5	2.5	< 1	< 0.1
21	36.00	DSN14SD02	<1	8.3	< 0.5	2.9	< 1	< 0.1
22	45.00	DSN14SD02	<1	7.8	< 0.5	2.1	< 1	< 0.1
23	Standard	DSN14SD02	<100	<200	< 50	<100	< 100	< 10
24	54.00	DSN14SD02	<1	<2	< 0.5	2.2	< 1	< 0.1
25	63.00	DSN14SD02	<1	<2	< 0.5	5	< 1	< 0.1
26	72.00	DSN14SD02	<1	<2	< 0.5	4.4	< 1	< 0.1
27	81.00	DSN14SD02	<1	11.2	< 0.5	5.2	< 1	< 0.1
28	90.00	DSN14SD02	<1	9.4	< 0.5	<1	< 1	< 0.1
29	99.00	DSN14SD02	<1	9.1	< 0.5	<1	< 1	< 0.1
30	Field blank	DSN14SD02	<1	<2	< 0.5	<1	< 1	< 0.1
31	Trip blank	DSN14SD02	<1	<2	< 0.5	<1	< 1	< 0.1
32	108.00	DSN14SD02	<1	4.2	< 0.5	1.1	< 1	< 0.1
33	Drilling water	DSN14SD03	<1	2.2	< 0.5	2.1	< 1	< 0.1

Field no.	Sample description/Sample depth, m	Borehole no.	ICPMS_LEACH Co/P ug/L	ICPMS_LEACH Cr/P ug/L	ICPMS_LEACH Cs/P ug/L	ICPMS_LEACH Cu/P ug/L	ICPMS_LEACH Dy/P ug/L	ICPMS_LEACH Er/P ug/L
34	9.00	DSN14SD03	<1	2.5	< 0.5	1.2	< 1	< 0.1
35	18.00	DSN14SD03	1.4	2.3	< 0.5	1.8	< 1	< 0.1
36	27.00	DSN14SD03	<1	2.6	< 0.5	2.7	< 1	< 0.1
37	Duplicate of no. 36	DSN14SD03	<1	2.7	< 0.5	1.6	< 1	< 0.1
38	36.00	DSN14SD03	<1	<2	< 0.5	1.2	< 1	< 0.1
39	45.00	DSN14SD03	<1	2.2	< 0.5	2.5	< 1	< 0.1
40	57.00	DSN14SD03	<1	2.7	< 0.5	1.6	< 1	< 0.1
41	Standard	DSN14SD03	<1	<2	< 0.5	1.2	< 1	< 0.1
42	63.00	DSN14SD03	<1	<2	< 0.5	1.2	< 1	< 0.1
43	9.00	DSN14SD04	<1	<2	< 0.5	2.3	< 1	< 0.1
44	18.00	DSN14SD04	<1	<2	< 0.5	2.8	< 1	< 0.1
45	27.00	DSN14SD04	<1	2.3	< 0.5	1.3	< 1	< 0.1
46	36.00	DSN14SD04	<1	<2	< 0.5	2.2	< 1	< 0.1
47	45.00	DSN14SD04	<1	<2	< 0.5	<1	< 1	< 0.1
48	Field blank	DSN14SD04	<1	<2	< 0.5	<1	< 1	< 0.1
49	Trip blank	DSN14SD04	<1	<2	< 0.5	<1	< 1	< 0.1

Field no.	Sample description/Sample depth, m	Borehole no.	ICPMS_LEACH Eu/P ug/L	ICPMS_LEACH Fe/P ug/L	ICPMS_LEACH Ga/P ug/L	ICPMS_LEACH Gd/P ug/L	ICPMS_LEACH Ge/P ug/L	ICPMS_LEACH Hf/P ug/L
1	Drilling water	DSN14SD01	< 0.5	<20	< 0.6	< 0.5	< 1	< 0.3
2	4.40	DSN14SD01	< 0.5	110	< 0.6	< 0.5	< 1	0.4
3	9.00	DSN14SD01	< 0.5	60	< 0.6	< 0.5	< 1	< 0.3
4	18.00	DSN14SD01	< 0.5	<20	< 0.6	< 0.5	< 1	< 0.3
5	Standard	DSN14SD01	< 5	<200	< 6	< 5	< 10	< 3
6	27.00	DSN14SD01	< 0.5	40	< 0.6	< 0.5	< 1	< 0.3
7	36.00	DSN14SD01	< 0.5	40	< 0.6	< 0.5	< 1	< 0.3
8	45.00	DSN14SD01	< 0.5	<20	< 0.6	< 0.5	< 1	< 0.3
9	54.00	DSN14SD01	< 0.5	<20	< 0.6	< 0.5	< 1	< 0.3
10	63.00	DSN14SD01	< 0.5	20	< 0.6	< 0.5	< 1	< 0.3
11	Duplicate of no. 10	DSN14SD01	< 0.5	30	< 0.6	< 0.5	< 1	< 0.3
12	72.00	DSN14SD01	< 0.5	<20	< 0.6	< 0.5	< 1	< 0.3
13	Field blank	DSN14SD01	< 0.5	<20	< 0.6	< 0.5	< 1	< 0.3
14	Trip blank	DSN14SD01	< 0.5	<20	< 0.6	< 0.5	< 1	< 0.3
15	81.00	DSN14SD01	< 0.5	<20	< 0.6	< 0.5	< 1	< 0.3
16	90.00	DSN14SD01	< 0.5	<20	< 0.6	< 0.5	< 1	< 0.3
17	9.00	DSN14SD02	< 0.5	<20	< 0.6	< 0.5	< 1	< 0.3
18	18.00	DSN14SD02	< 0.5	<20	< 0.6	< 0.5	< 1	< 0.3
19	27.00	DSN14SD02	< 0.5	<20	< 0.6	< 0.5	< 1	< 0.3
20	Duplicate of no. 19	DSN14SD02	< 0.5	<20	< 0.6	< 0.5	< 1	< 0.3
21	36.00	DSN14SD02	< 0.5	<20	< 0.6	< 0.5	< 1	< 0.3
22	45.00	DSN14SD02	< 0.5	<20	< 0.6	< 0.5	< 1	< 0.3
23	Standard	DSN14SD02	< 50	<2,000	< 60	< 50	< 100	< 30
24	54.00	DSN14SD02	< 0.5	<20	< 0.6	< 0.5	< 1	< 0.3
25	63.00	DSN14SD02	< 0.5	<20	< 0.6	< 0.5	< 1	< 0.3
26	72.00	DSN14SD02	< 0.5	<20	< 0.6	< 0.5	< 1	< 0.3
27	81.00	DSN14SD02	< 0.5	<20	< 0.6	< 0.5	< 1	< 0.3
28	90.00	DSN14SD02	< 0.5	<20	< 0.6	< 0.5	< 1	< 0.3
29	99.00	DSN14SD02	< 0.5	<20	< 0.6	< 0.5	< 1	< 0.3
30	Field blank	DSN14SD02	< 0.5	<20	< 0.6	< 0.5	< 1	< 0.3
31	Trip blank	DSN14SD02	< 0.5	<20	< 0.6	< 0.5	< 1	< 0.3
32	108.00	DSN14SD02	< 0.5	<20	< 0.6	< 0.5	< 1	< 0.3
33	Drilling water	DSN14SD03	< 0.5	<20	< 0.6	< 0.5	< 1	< 0.3

Field no.	Sample description/Sample depth, m	Borehole no.	ICPMS_LEACH Eu/P ug/L	ICPMS_LEACH Fe/P ug/L	ICPMS_LEACH Ga/P ug/L	ICPMS_LEACH Gd/P ug/L	ICPMS_LEACH Ge/P ug/L	ICPMS_LEACH Hf/P ug/L
34	9.00	DSN14SD03	< 0.5	<20	< 0.6	< 0.5	< 1	< 0.3
35	18.00	DSN14SD03	< 0.5	<20	< 0.6	< 0.5	< 1	< 0.3
36	27.00	DSN14SD03	< 0.5	<20	< 0.6	< 0.5	< 1	< 0.3
37	Duplicate of no. 36	DSN14SD03	< 0.5	<20	< 0.6	< 0.5	< 1	< 0.3
38	36.00	DSN14SD03	< 0.5	40	< 0.6	< 0.5	< 1	< 0.3
39	45.00	DSN14SD03	< 0.5	40	< 0.6	< 0.5	< 1	< 0.3
40	57.00	DSN14SD03	< 0.5	20	< 0.6	< 0.5	< 1	< 0.3
41	Standard	DSN14SD03	< 0.5	<20	< 0.6	< 0.5	< 1	< 0.3
42	63.00	DSN14SD03	< 0.5	<20	< 0.6	< 0.5	< 1	< 0.3
43	9.00	DSN14SD04	< 0.5	<20	< 0.6	< 0.5	< 1	< 0.3
44	18.00	DSN14SD04	< 0.5	<20	< 0.6	< 0.5	< 1	< 0.3
45	27.00	DSN14SD04	< 0.5	60	< 0.6	< 0.5	< 1	< 0.3
46	36.00	DSN14SD04	< 0.5	40	< 0.6	< 0.5	< 1	< 0.3
47	45.00	DSN14SD04	< 0.5	<20	< 0.6	< 0.5	< 1	< 0.3
48	Field blank	DSN14SD04	< 0.5	<20	< 0.6	< 0.5	< 1	< 0.3
49	Trip blank	DSN14SD04	< 0.5	<20	< 0.6	< 0.5	< 1	< 0.3

Field no.	Sample description/Sample depth, m	Borehole no.	ICPMS_LEACH Ho/P ug/L	ICPMS_LEACH In/P ug/L	ICPMS_LEACH K/P mg/L	ICPMS_LEACH La/P ug/L	ICPMS_LEACH Li/P ug/L	ICPMS_LEACH Lu/P ug/L
1	Drilling water	DSN14SD01	< 0.1	< 0.5	0.68	< 0.1	< 50	< 0.3
2	4.40	DSN14SD01	< 0.1	< 0.5	40.3	< 0.1	76.3	< 0.3
3	9.00	DSN14SD01	< 0.1	< 0.5	20.4	< 0.1	77.9	< 0.3
4	18.00	DSN14SD01	< 0.1	< 0.5	11.1	< 0.1	< 50	< 0.3
5	Standard	DSN14SD01	< 1	< 5	<5	< 1	366,000	< 3
6	27.00	DSN14SD01	< 0.1	< 0.5	8.1	< 0.1	97.2	< 0.3
7	36.00	DSN14SD01	< 0.1	< 0.5	8	< 0.1	75.7	< 0.3
8	45.00	DSN14SD01	< 0.1	< 0.5	3.8	< 0.1	< 50	< 0.3
9	54.00	DSN14SD01	< 0.1	< 0.5	4.3	< 0.1	56	< 0.3
10	63.00	DSN14SD01	< 0.1	< 0.5	3.2	< 0.1	< 50	< 0.3
11	Duplicate of no. 10	DSN14SD01	< 0.1	< 0.5	3.3	< 0.1	64.5	< 0.3
12	72.00	DSN14SD01	< 0.1	< 0.5	7.3	< 0.1	65.7	< 0.3
13	Field blank	DSN14SD01	< 0.1	< 0.5	<0.5	< 0.1	< 50	< 0.3
14	Trip blank	DSN14SD01	< 0.1	< 0.5	<0.5	< 0.1	< 50	< 0.3
15	81.00	DSN14SD01	< 0.1	< 0.5	4.4	< 0.1	63.7	< 0.3
16	90.00	DSN14SD01	< 0.1	< 0.5	3	< 0.1	95.6	< 0.3
17	9.00	DSN14SD02	< 0.1	< 0.5	4.4	< 0.1	< 50	< 0.3
18	18.00	DSN14SD02	< 0.1	< 0.5	9.1	< 0.1	< 50	< 0.3
19	27.00	DSN14SD02	< 0.1	< 0.5	4.8	< 0.1	64.6	< 0.3
20	Duplicate of no. 19	DSN14SD02	< 0.1	< 0.5	4.8	< 0.1	72.2	< 0.3
21	36.00	DSN14SD02	< 0.1	< 0.5	2.9	< 0.1	50.8	< 0.3
22	45.00	DSN14SD02	< 0.1	< 0.5	3	< 0.1	64.5	< 0.3
23	Standard	DSN14SD02	< 10	< 50	3,080	< 10	370,000	< 30
24	54.00	DSN14SD02	< 0.1	< 0.5	11.7	< 0.1	< 50	< 0.3
25	63.00	DSN14SD02	< 0.1	< 0.5	7.1	< 0.1	< 50	< 0.3
26	72.00	DSN14SD02	< 0.1	< 0.5	4.4	< 0.1	< 50	< 0.3
27	81.00	DSN14SD02	< 0.1	< 0.5	59.9	< 0.1	186	< 0.3
28	90.00	DSN14SD02	< 0.1	< 0.5	40.8	< 0.1	136	< 0.3
29	99.00	DSN14SD02	< 0.1	< 0.5	23.9	< 0.1	115	< 0.3
30	Field blank	DSN14SD02	< 0.1	< 0.5	<0.5	< 0.1	< 50	< 0.3
31	Trip blank	DSN14SD02	< 0.1	< 0.5	<0.5	< 0.1	< 50	< 0.3
32	108.00	DSN14SD02	< 0.1	< 0.5	12.5	< 0.1	85.6	< 0.3
33	Drilling water	DSN14SD03	< 0.1	< 0.5	2	< 0.1	< 50	< 0.3

Field no.	Sample description/Sample depth, m	Borehole no.	ICPMS_LEACH Ho/P ug/L	ICPMS_LEACH In/P ug/L	ICPMS_LEACH K/P mg/L	ICPMS_LEACH La/P ug/L	ICPMS_LEACH Li/P ug/L	ICPMS_LEACH Lu/P ug/L
34	9.00	DSN14SD03	< 0.1	< 0.5	6.9	< 0.1	74.2	< 0.3
35	18.00	DSN14SD03	< 0.1	< 0.5	5	< 0.1	< 50	< 0.3
36	27.00	DSN14SD03	< 0.1	< 0.5	4.9	< 0.1	< 50	< 0.3
37	Duplicate of no. 36	DSN14SD03	< 0.1	< 0.5	4.9	< 0.1	< 50	< 0.3
38	36.00	DSN14SD03	< 0.1	< 0.5	7.8	< 0.1	104	< 0.3
39	45.00	DSN14SD03	< 0.1	< 0.5	5.8	< 0.1	< 50	< 0.3
40	57.00	DSN14SD03	< 0.1	< 0.5	13.6	< 0.1	68.9	< 0.3
41	Standard	DSN14SD03	< 0.1	< 0.5	9.1	< 0.1	8,990	< 0.3
42	63.00	DSN14SD03	< 0.1	< 0.5	6.5	< 0.1	< 50	< 0.3
43	9.00	DSN14SD04	< 0.1	< 0.5	4.1	< 0.1	< 50	< 0.3
44	18.00	DSN14SD04	< 0.1	< 0.5	4.4	< 0.1	< 50	< 0.3
45	27.00	DSN14SD04	< 0.1	< 0.5	5.3	< 0.1	< 50	< 0.3
46	36.00	DSN14SD04	< 0.1	< 0.5	1.2	< 0.1	< 50	< 0.3
47	45.00	DSN14SD04	< 0.1	< 0.5	2.6	< 0.1	< 50	< 0.3
48	Field blank	DSN14SD04	< 0.1	< 0.5	<0.5	< 0.1	< 50	< 0.3
49	Trip blank	DSN14SD04	< 0.1	< 0.5	<0.5	< 0.1	< 50	< 0.3

Field no.	Sample description/Sample depth, m	Borehole no.	ICPMS_LEACH Mg/P mg/L	ICPMS_LEACH Mn/P ug/L	ICPMS_LEACH Mo/P ug/L	ICPMS_LEACH Na/P mg/L	ICPMS_LEACH Nb/P ug/L	ICPMS_LEACH Nd/P ug/L
1	Drilling water	DSN14SD01	13.4	<5	< 1	5.6	< 4	< 0.2
2	4.40	DSN14SD01	243	133	39.7	1,090	< 4	< 0.2
3	9.00	DSN14SD01	153	44.6	14.6	579	< 4	< 0.2
4	18.00	DSN14SD01	57.8	<5	8.1	173	< 4	< 0.2
5	Standard	DSN14SD01	0.21	<50	< 10	1.4	< 40	< 2
6	27.00	DSN14SD01	63	<5	8	183	< 4	< 0.2
7	36.00	DSN14SD01	29.3	37.2	11.7	42.1	< 4	< 0.2
8	45.00	DSN14SD01	24.5	7.9	5.8	21.4	< 4	< 0.2
9	54.00	DSN14SD01	25.8	35.9	4.3	20.8	< 4	< 0.2
10	63.00	DSN14SD01	31.8	<5	4.8	18.4	< 4	< 0.2
11	Duplicate of no. 10	DSN14SD01	32.4	<5	4.7	18.6	< 4	< 0.2
12	72.00	DSN14SD01	25.3	59.5	7.5	21.5	< 4	< 0.2
13	Field blank	DSN14SD01	0.37	<5	< 1	0.2	< 4	< 0.2
14	Trip blank	DSN14SD01	<0.01	<5	< 1	<0.1	< 4	< 0.2
15	81.00	DSN14SD01	19.7	94.8	7.6	16.5	< 4	< 0.2
16	90.00	DSN14SD01	28.7	109	4.8	16.4	< 4	< 0.2
17	9.00	DSN14SD02	28.1	7.1	2.4	18.7	< 4	< 0.2
18	18.00	DSN14SD02	31	5.3	18.7	44.3	< 4	< 0.2
19	27.00	DSN14SD02	26.5	5.1	5.2	20.5	< 4	< 0.2
20	Duplicate of no. 19	DSN14SD02	26.8	10.1	4.4	20.6	< 4	< 0.2
21	36.00	DSN14SD02	29.8	39.8	1.6	16	< 4	< 0.2
22	45.00	DSN14SD02	30.6	45.1	3.1	15.9	< 4	< 0.2
23	Standard	DSN14SD02	<1	<500	< 100	1,130	< 400	< 20
24	54.00	DSN14SD02	39.8	13.4	21	52	< 4	< 0.2
25	63.00	DSN14SD02	31.2	<5	4.8	19.3	< 4	< 0.2
26	72.00	DSN14SD02	32.4	28.6	2.9	19.2	< 4	< 0.2
27	81.00	DSN14SD02	96.2	30.8	19.4	509	< 4	< 0.2
28	90.00	DSN14SD02	13.7	<5	171	329	< 4	< 0.2
29	99.00	DSN14SD02	24.1	9.5	24.6	215	< 4	< 0.2
30	Field blank	DSN14SD02	1.4	8.9	< 1	0.71	< 4	< 0.2
31	Trip blank	DSN14SD02	<0.01	<5	< 1	<0.1	< 4	< 0.2
32	108.00	DSN14SD02	28.2	45.3	16.4	74	< 4	< 0.2
33	Drilling water	DSN14SD03	28.8	<5	< 1	15.2	< 4	< 0.2

Field no.	Sample description/Sample depth, m	Borehole no.	ICPMS_LEACH Mg/P mg/L	ICPMS_LEACH Mn/P ug/L	ICPMS_LEACH Mo/P ug/L	ICPMS_LEACH Na/P mg/L	ICPMS_LEACH Nb/P ug/L	ICPMS_LEACH Nd/P ug/L
34	9.00	DSN14SD03	55.2	35.6	13.9	62.8	< 4	< 0.2
35	18.00	DSN14SD03	37.6	<5	7.3	34.7	< 4	< 0.2
36	27.00	DSN14SD03	35	32.9	8.1	23	< 4	< 0.2
37	Duplicate of no. 36	DSN14SD03	34.7	21.2	7.6	22.8	< 4	< 0.2
38	36.00	DSN14SD03	12.6	14.3	10.8	61.2	< 4	< 0.2
39	45.00	DSN14SD03	30.9	9.4	13.5	29.1	< 4	< 0.2
40	57.00	DSN14SD03	33	7.9	22.8	119	< 4	< 0.2
41	Standard	DSN14SD03	0.07	<5	< 1	0.63	< 4	< 0.2
42	63.00	DSN14SD03	31.5	21.1	36.4	12.6	< 4	< 0.2
43	9.00	DSN14SD04	29.8	10.4	9.5	7	< 4	< 0.2
44	18.00	DSN14SD04	24.5	70.9	10.4	8.7	< 4	< 0.2
45	27.00	DSN14SD04	27	56.7	5.3	7.2	< 4	< 0.2
46	36.00	DSN14SD04	22.2	<5	4	3.1	< 4	< 0.2
47	45.00	DSN14SD04	12.1	68.1	6.1	3	< 4	< 0.2
48	Field blank	DSN14SD04	0.18	<5	< 1	0.12	< 4	< 0.2
49	Trip blank	DSN14SD04	<0.01	<5	< 1	<0.1	< 4	< 0.2

Field no.	Sample Description/Sample depth, m	Borehole no.	ICPMS_LEACH Ni/P ug/L	ICPMS_LEACH P/P mg/L	ICPMS_LEACH Pb/P ug/L	ICPMS_LEACH Pr/P ug/L	ICPMS_LEACH Rb/P ug/L	ICPMS_LEACH S/P mg/L
1	Drilling water	DSN14SD01	<1	< 0.2	<0.2	< 0.05	0.23	< 10
2	4.40	DSN14SD01	2.2	< 0.2	0.26	< 0.05	3.7	550
3	9.00	DSN14SD01	1.3	0.3	<0.2	< 0.05	2.8	310
4	18.00	DSN14SD01	<1	< 0.2	<0.2	< 0.05	1.6	86
5	Standard	DSN14SD01	<10	< 2	43.3	< 0.5	< 2	< 100
6	27.00	DSN14SD01	<1	0.2	0.58	< 0.05	1.3	85
7	36.00	DSN14SD01	1.6	0.3	<0.2	< 0.05	1.2	< 10
8	45.00	DSN14SD01	<1	< 0.2	0.23	< 0.05	0.77	< 10
9	54.00	DSN14SD01	<1	< 0.2	<0.2	< 0.05	0.55	< 10
10	63.00	DSN14SD01	1.4	< 0.2	<0.2	< 0.05	1.1	< 10
11	Duplicate of no. 10	DSN14SD01	<1	< 0.2	<0.2	< 0.05	0.94	< 10
12	72.00	DSN14SD01	<1	0.3	0.47	< 0.05	1.4	< 10
13	Field blank	DSN14SD01	<1	< 0.2	<0.2	< 0.05	< 0.2	< 10
14	Trip blank	DSN14SD01	<1	< 0.2	<0.2	< 0.05	< 0.2	< 10
15	81.00	DSN14SD01	<1	0.3	<0.2	< 0.05	1.7	< 10
16	90.00	DSN14SD01	1.5	0.4	0.35	< 0.05	1.9	< 10
17	9.00	DSN14SD02	<1	< 0.2	<0.2	< 0.05	1.5	< 10
18	18.00	DSN14SD02	<1	< 0.2	<0.2	< 0.05	1.3	13
19	27.00	DSN14SD02	<1	< 0.2	<0.2	< 0.05	1.3	< 10
20	Duplicate of no. 19	DSN14SD02	<1	0.2	<0.2	< 0.05	1.3	< 10
21	36.00	DSN14SD02	<1	< 0.2	<0.2	< 0.05	1.4	< 10
22	45.00	DSN14SD02	<1	< 0.2	<0.2	< 0.05	1.6	< 10
23	Standard	DSN14SD02	<100	< 20	70.5	< 5	273	< 1,000
24	54.00	DSN14SD02	3.2	3.5	<0.2	< 0.05	1.9	13
25	63.00	DSN14SD02	2.4	3.5	<0.2	< 0.05	1.3	< 10
26	72.00	DSN14SD02	<1	3.7	<0.2	< 0.05	1.4	< 10
27	81.00	DSN14SD02	4	0.8	<0.2	< 0.05	5.8	170
28	90.00	DSN14SD02	4.4	0.7	2.58	< 0.05	4.3	32
29	99.00	DSN14SD02	3.3	0.2	<0.2	< 0.05	3.4	< 10
30	Field blank	DSN14SD02	<1	< 0.2	<0.2	< 0.05	< 0.2	< 10
31	Trip blank	DSN14SD02	<1	< 0.2	<0.2	< 0.05	< 0.2	< 10
32	108.00	DSN14SD02	1.9	< 0.2	1.62	< 0.05	2	< 10
33	Drilling water	DSN14SD03	<1	< 0.2	1.54	< 0.05	1.6	< 10

Field no.	Sample Description/Sample depth, m	Borehole no.	ICPMS_LEACH Ni/P ug/L	ICPMS_LEACH P/P mg/L	ICPMS_LEACH Pb/P ug/L	ICPMS_LEACH Pr/P ug/L	ICPMS_LEACH Rb/P ug/L	ICPMS_LEACH S/P mg/L
34	9.00	DSN14SD03	<1	< 0.2	1.57	< 0.05	1.3	40
35	18.00	DSN14SD03	1.4	0.2	2.04	< 0.05	1.2	< 10
36	27.00	DSN14SD03	1.5	< 0.2	2.22	< 0.05	1.1	< 10
37	Duplicate of no. 36	DSN14SD03	1.3	< 0.2	5.19	< 0.05	1.2	< 10
38	36.00	DSN14SD03	1	< 0.2	2.42	< 0.05	8.2	< 10
39	45.00	DSN14SD03	1.4	< 0.2	4.24	< 0.05	2	< 10
40	57.00	DSN14SD03	2.6	0.6	3.63	< 0.05	2	< 10
41	Standard	DSN14SD03	<1	< 0.2	28.5	< 0.05	< 0.2	< 10
42	63.00	DSN14SD03	2	< 0.2	0.23	< 0.05	1.5	< 10
43	9.00	DSN14SD04	<1	< 0.2	<0.2	< 0.05	0.96	< 10
44	18.00	DSN14SD04	<1	0.2	0.22	< 0.05	1.8	< 10
45	27.00	DSN14SD04	1.5	< 0.2	0.24	< 0.05	1.6	< 10
46	36.00	DSN14SD04	<1	< 0.2	0.4	< 0.05	0.53	< 10
47	45.00	DSN14SD04	<1	< 0.2	0.24	< 0.05	0.33	< 10
48	Field blank	DSN14SD04	<1	< 0.2	0.63	< 0.05	< 0.2	< 10
49	Trip blank	DSN14SD04	<1	< 0.2	0.24	< 0.05	< 0.2	< 10

Field no.	Sample description/Sample depth, m	Borehole no.	ICPMS_LEACH Sb/P ug/L	ICPMS_LEACH Sc/P ug/L	ICPMS_LEACH Se/P ug/L	ICPMS_LEACH Si/P mg/L	ICPMS_LEACH Sm/P ug/L	ICPMS_LEACH Sn/P ug/L
1	Drilling water	DSN14SD01	<1	< 1	< 10	< 10	< 0.5	< 2
2	4.40	DSN14SD01	1.1	< 1	15.3	< 10	< 0.5	< 2
3	9.00	DSN14SD01	<1	< 1	< 10	< 10	< 0.5	< 2
4	18.00	DSN14SD01	<1	< 1	< 10	< 10	< 0.5	< 2
5	Standard	DSN14SD01	26.7	< 10	< 100	< 100	< 5	< 20
6	27.00	DSN14SD01	<1	< 1	< 10	< 10	< 0.5	< 2
7	36.00	DSN14SD01	1.7	< 1	< 10	< 10	< 0.5	< 2
8	45.00	DSN14SD01	1.9	1.2	< 10	< 10	< 0.5	< 2
9	54.00	DSN14SD01	1.4	< 1	< 10	< 10	< 0.5	< 2
10	63.00	DSN14SD01	<1	1.6	< 10	12	< 0.5	< 2
11	Duplicate of no. 10	DSN14SD01	<1	1.5	< 10	13	< 0.5	< 2
12	72.00	DSN14SD01	1.1	1.1	< 10	11	< 0.5	< 2
13	Field blank	DSN14SD01	<1	< 1	< 10	< 10	< 0.5	< 2
14	Trip blank	DSN14SD01	<1	< 1	< 10	< 10	< 0.5	< 2
15	81.00	DSN14SD01	<1	< 1	< 10	< 10	< 0.5	< 2
16	90.00	DSN14SD01	<1	< 1	< 10	< 10	< 0.5	< 2
17	9.00	DSN14SD02	<1	< 1	< 10	< 10	< 0.5	< 2
18	18.00	DSN14SD02	2.1	1.2	< 10	14	< 0.5	< 2
19	27.00	DSN14SD02	<1	< 1	< 10	< 10	< 0.5	< 2
20	Duplicate of no. 19	DSN14SD02	<1	< 1	< 10	< 10	< 0.5	< 2
21	36.00	DSN14SD02	<1	< 1	< 10	10	< 0.5	< 2
22	45.00	DSN14SD02	<1	< 1	< 10	10	< 0.5	< 2
23	Standard	DSN14SD02	141	< 100	< 1,000	< 1,000	< 50	< 200
24	54.00	DSN14SD02	5.1	3	< 10	28	< 0.5	< 2
25	63.00	DSN14SD02	3.1	2.4	< 10	27	< 0.5	< 2
26	72.00	DSN14SD02	1.8	2.1	< 10	28	< 0.5	< 2
27	81.00	DSN14SD02	1.8	< 1	< 10	13	< 0.5	< 2
28	90.00	DSN14SD02	9	< 1	< 10	11	< 0.5	< 2
29	99.00	DSN14SD02	3	< 1	< 10	< 10	< 0.5	< 2
30	Field blank	DSN14SD02	<1	< 1	< 10	< 10	< 0.5	< 2
31	Trip blank	DSN14SD02	<1	< 1	< 10	< 10	< 0.5	< 2
32	108.00	DSN14SD02	1.8	< 1	< 10	< 10	< 0.5	< 2
33	Drilling water	DSN14SD03	<1	< 1	< 10	10	< 0.5	< 2

Field no.	Sample description/Sample depth, m	Borehole no.	ICPMS_LEACH Sb/P ug/L	ICPMS_LEACH Sc/P ug/L	ICPMS_LEACH Se/P ug/L	ICPMS_LEACH Si/P mg/L	ICPMS_LEACH Sm/P ug/L	ICPMS_LEACH Sn/P ug/L
34	9.00	DSN14SD03	1.2	< 1	< 10	< 10	< 0.5	< 2
35	18.00	DSN14SD03	1.6	< 1	< 10	13	< 0.5	< 2
36	27.00	DSN14SD03	1	< 1	< 10	< 10	< 0.5	< 2
37	Duplicate of no. 36	DSN14SD03	<1	< 1	< 10	< 10	< 0.5	< 2
38	36.00	DSN14SD03	<1	3.3	< 10	25	< 0.5	< 2
39	45.00	DSN14SD03	<1	< 1	< 10	13	< 0.5	< 2
40	57.00	DSN14SD03	6.5	1.7	< 10	19	< 0.5	< 2
41	Standard	DSN14SD03	<1	< 1	< 10	< 10	< 0.5	< 2
42	63.00	DSN14SD03	2.9	< 1	< 10	< 10	< 0.5	< 2
43	9.00	DSN14SD04	1.2	< 1	< 10	13	< 0.5	< 2
44	18.00	DSN14SD04	<1	< 1	< 10	14	< 0.5	< 2
45	27.00	DSN14SD04	3.2	< 1	< 10	12	< 0.5	< 2
46	36.00	DSN14SD04	<1	< 1	< 10	< 10	< 0.5	< 2
47	45.00	DSN14SD04	<1	< 1	< 10	< 10	< 0.5	< 2
48	Field blank	DSN14SD04	<1	< 1	< 10	< 10	< 0.5	< 2
49	Trip blank	DSN14SD04	<1	< 1	< 10	< 10	< 0.5	< 2

Field no.	Sample description/Sample depth, m	Borehole no.	ICPMS_LEACH Sr/P ug/L	ICPMS_LEACH Ta/P ug/L	ICPMS_LEACH Tb/P ug/L	ICPMS_LEACH Te/P ug/L	ICPMS_LEACH Th/P ug/L	ICPMS_LEACH Ti/P ug/L
1	Drilling water	DSN14SD01	54.5	< 3	< 0.1	< 2	< 2	< 10
2	4.40	DSN14SD01	1,460	< 3	< 0.1	< 2	< 2	24.2
3	9.00	DSN14SD01	1,090	< 3	< 0.1	< 2	< 2	15.6
4	18.00	DSN14SD01	515	< 3	< 0.1	< 2	< 2	< 10
5	Standard	DSN14SD01	6.4	< 30	< 1	< 20	23.5	< 100
6	27.00	DSN14SD01	571	< 3	< 0.1	< 2	< 2	< 10
7	36.00	DSN14SD01	376	< 3	< 0.1	< 2	< 2	< 10
8	45.00	DSN14SD01	369	< 3	< 0.1	< 2	< 2	< 10
9	54.00	DSN14SD01	461	< 3	< 0.1	< 2	< 2	< 10
10	63.00	DSN14SD01	492	< 3	< 0.1	< 2	< 2	< 10
11	Duplicate of no. 10	DSN14SD01	485	< 3	< 0.1	< 2	< 2	< 10
12	72.00	DSN14SD01	502	< 3	< 0.1	< 2	< 2	< 10
13	Field blank	DSN14SD01	6.9	< 3	< 0.1	< 2	< 2	< 10
14	Trip blank	DSN14SD01	< 0.5	< 3	< 0.1	< 2	< 2	< 10
15	81.00	DSN14SD01	382	< 3	< 0.1	< 2	< 2	< 10
16	90.00	DSN14SD01	449	< 3	< 0.1	< 2	< 2	< 10
17	9.00	DSN14SD02	424	< 3	< 0.1	< 2	< 2	< 10
18	18.00	DSN14SD02	429	< 3	< 0.1	< 2	< 2	< 10
19	27.00	DSN14SD02	410	< 3	< 0.1	< 2	< 2	< 10
20	Duplicate of no. 19	DSN14SD02	422	< 3	< 0.1	< 2	< 2	< 10
21	36.00	DSN14SD02	453	< 3	< 0.1	< 2	< 2	< 10
22	45.00	DSN14SD02	447	< 3	< 0.1	< 2	< 2	< 10
23	Standard	DSN14SD02	173	< 300	< 10	< 200	< 200	< 1,000
24	54.00	DSN14SD02	508	< 3	< 0.1	< 2	< 2	< 10
25	63.00	DSN14SD02	422	< 3	< 0.1	< 2	< 2	< 10
26	72.00	DSN14SD02	454	< 3	< 0.1	< 2	< 2	< 10
27	81.00	DSN14SD02	1,070	< 3	< 0.1	< 2	< 2	< 10
28	90.00	DSN14SD02	289	< 3	< 0.1	< 2	< 2	< 10
29	99.00	DSN14SD02	458	< 3	< 0.1	< 2	< 2	< 10
30	Field blank	DSN14SD02	25	< 3	< 0.1	< 2	< 2	< 10
31	Trip blank	DSN14SD02	< 0.5	< 3	< 0.1	< 2	< 2	< 10
32	108.00	DSN14SD02	440	< 3	< 0.1	< 2	< 2	< 10
33	Drilling water	DSN14SD03	422	< 3	< 0.1	< 2	< 2	< 10

Field no.	Sample description/Sample depth, m	Borehole no.	ICPMS_LEACH Sr/P ug/L	ICPMS_LEACH Ta/P ug/L	ICPMS_LEACH Tb/P ug/L	ICPMS_LEACH Te/P ug/L	ICPMS_LEACH Th/P ug/L	ICPMS_LEACH Ti/P ug/L
34	9.00	DSN14SD03	501	< 3	< 0.1	< 2	< 2	< 10
35	18.00	DSN14SD03	572	< 3	< 0.1	< 2	< 2	< 10
36	27.00	DSN14SD03	449	< 3	< 0.1	< 2	< 2	< 10
37	Duplicate of no. 36	DSN14SD03	460	< 3	< 0.1	< 2	< 2	< 10
38	36.00	DSN14SD03	191	< 3	< 0.1	< 2	< 2	< 10
39	45.00	DSN14SD03	438	< 3	< 0.1	< 2	< 2	< 10
40	57.00	DSN14SD03	370	< 3	< 0.1	< 2	< 2	< 10
41	Standard	DSN14SD03	1.4	< 3	< 0.1	< 2	< 2	< 10
42	63.00	DSN14SD03	301	< 3	< 0.1	< 2	< 2	< 10
43	9.00	DSN14SD04	284	< 3	< 0.1	< 2	< 2	< 10
44	18.00	DSN14SD04	298	< 3	< 0.1	< 2	< 2	< 10
45	27.00	DSN14SD04	327	< 3	< 0.1	< 2	< 2	< 10
46	36.00	DSN14SD04	147	< 3	< 0.1	< 2	< 2	< 10
47	45.00	DSN14SD04	157	< 3	< 0.1	< 2	< 2	< 10
48	Field blank	DSN14SD04	1.6	< 3	< 0.1	< 2	< 2	< 10
49	Trip blank	DSN14SD04	< 0.5	< 3	< 0.1	< 2	< 2	< 10

Field no.	Sample description/Sample depth, m	Borehole no.	ICPMS_LEACH Tl/P ug/L	ICPMS_LEACH Tm/P ug/L	ICPMS_LEACH U/P ug/L	ICPMS_LEACH V/P ug/L	ICPMS_LEACH W/P ug/L	ICPMS_LEACH Y/P ug/L
1	Drilling water	DSN14SD01	0.36	< 0.1	0.32	<2	< 1	< 0.1
2	4.40	DSN14SD01	1.72	< 0.1	15.4	<2	1.2	< 0.1
3	9.00	DSN14SD01	<0.2	< 0.1	11.6	<2	< 1	< 0.1
4	18.00	DSN14SD01	<0.2	< 0.1	5.03	<2	< 1	< 0.1
5	Standard	DSN14SD01	<2	< 1	0.94	<20	19	< 1
6	27.00	DSN14SD01	<0.2	< 0.1	3.19	<2	< 1	< 0.1
7	36.00	DSN14SD01	0.42	< 0.1	0.68	<2	2.3	< 0.1
8	45.00	DSN14SD01	<0.2	< 0.1	0.72	<2	1.6	< 0.1
9	54.00	DSN14SD01	<0.2	< 0.1	0.35	<2	1.7	< 0.1
10	63.00	DSN14SD01	<0.2	< 0.1	0.39	<2	< 1	< 0.1
11	Duplicate of no. 10	DSN14SD01	<0.2	< 0.1	0.47	<2	< 1	< 0.1
12	72.00	DSN14SD01	<0.2	< 0.1	1.5	<2	1.2	< 0.1
13	Field blank	DSN14SD01	<0.2	< 0.1	< 0.05	<2	< 1	< 0.1
14	Trip blank	DSN14SD01	<0.2	< 0.1	< 0.05	<2	< 1	< 0.1
15	81.00	DSN14SD01	<0.2	< 0.1	0.36	<2	1	< 0.1
16	90.00	DSN14SD01	<0.2	< 0.1	0.24	<2	< 1	< 0.1
17	9.00	DSN14SD02	<0.2	< 0.1	1.25	3	< 1	< 0.1
18	18.00	DSN14SD02	<0.2	< 0.1	4.66	11.5	< 1	< 0.1
19	27.00	DSN14SD02	<0.2	< 0.1	2.24	4.3	< 1	< 0.1
20	Duplicate of no. 19	DSN14SD02	<0.2	< 0.1	2.27	4.9	< 1	< 0.1
21	36.00	DSN14SD02	<0.2	< 0.1	0.54	<2	< 1	< 0.1
22	45.00	DSN14SD02	<0.2	< 0.1	0.41	<2	< 1	< 0.1
23	Standard	DSN14SD02	<20	< 10	< 5	<200	< 100	< 10
24	54.00	DSN14SD02	<0.2	< 0.1	3.99	5	2.4	< 0.1
25	63.00	DSN14SD02	<0.2	< 0.1	0.72	<2	1.5	< 0.1
26	72.00	DSN14SD02	<0.2	< 0.1	0.58	<2	1.2	< 0.1
27	81.00	DSN14SD02	<0.2	< 0.1	1.38	11.5	1.6	< 0.1
28	90.00	DSN14SD02	<0.2	< 0.1	7.4	3.1	2.8	< 0.1
29	99.00	DSN14SD02	<0.2	< 0.1	1.27	2.1	2.5	< 0.1
30	Field blank	DSN14SD02	<0.2	< 0.1	0.07	<2	< 1	< 0.1
31	Trip blank	DSN14SD02	<0.2	< 0.1	< 0.05	<2	< 1	< 0.1
32	108.00	DSN14SD02	<0.2	< 0.1	0.7	<2	< 1	< 0.1
33	Drilling water	DSN14SD03	<0.2	< 0.1	0.22	<2	< 1	< 0.1

Field no.	Sample description/Sample depth, m	Borehole no.	ICPMS_LEACH Tl/P ug/L	ICPMS_LEACH Tm/P ug/L	ICPMS_LEACH U/P ug/L	ICPMS_LEACH V/P ug/L	ICPMS_LEACH W/P ug/L	ICPMS_LEACH Y/P ug/L
34	9.00	DSN14SD03	<0.2	< 0.1	7.18	2.7	< 1	< 0.1
35	18.00	DSN14SD03	<0.2	< 0.1	10.5	5.7	< 1	< 0.1
36	27.00	DSN14SD03	<0.2	< 0.1	1.19	<2	< 1	< 0.1
37	Duplicate of no. 36	DSN14SD03	<0.2	< 0.1	1.23	<2	< 1	< 0.1
38	36.00	DSN14SD03	<0.2	< 0.1	0.95	<2	1.2	< 0.1
39	45.00	DSN14SD03	<0.2	< 0.1	3.35	2.7	< 1	< 0.1
40	57.00	DSN14SD03	<0.2	< 0.1	3.16	<2	1.2	< 0.1
41	Standard	DSN14SD03	<0.2	< 0.1	< 0.05	<2	< 1	< 0.1
42	63.00	DSN14SD03	0.21	< 0.1	7.88	<2	2	< 0.1
43	9.00	DSN14SD04	<0.2	< 0.1	1.89	<2	1.3	< 0.1
44	18.00	DSN14SD04	<0.2	< 0.1	1.17	<2	3.7	< 0.1
45	27.00	DSN14SD04	<0.2	< 0.1	31.2	<2	1.5	< 0.1
46	36.00	DSN14SD04	<0.2	< 0.1	0.94	<2	< 1	< 0.1
47	45.00	DSN14SD04	<0.2	< 0.1	0.92	<2	2.1	< 0.1
48	Field blank	DSN14SD04	<0.2	< 0.1	< 0.05	<2	< 1	< 0.1
49	Trip blank	DSN14SD04	<0.2	< 0.1	< 0.05	<2	< 1	< 0.1

Field no.	Sample description/Sample depth, m	Borehole no.	ICPMS_LEACH Yb/P ug/L	ICPMS_LEACH Zn/P ug/L	ICPMS_LEACH Zr/P ug/L
1	Drilling water	DSN14SD01	< 0.1	72.1	< 1
2	4.40	DSN14SD01	< 0.1	115	1.1
3	9.00	DSN14SD01	< 0.1	212	< 1
4	18.00	DSN14SD01	< 0.1	554	< 1
5	Standard	DSN14SD01	< 1	160	< 10
6	27.00	DSN14SD01	< 0.1	163	< 1
7	36.00	DSN14SD01	< 0.1	43.2	< 1
8	45.00	DSN14SD01	< 0.1	559	< 1
9	54.00	DSN14SD01	< 0.1	166	< 1
10	63.00	DSN14SD01	< 0.1	1420	< 1
11	Duplicate of no. 10	DSN14SD01	< 0.1	1130	< 1
12	72.00	DSN14SD01	< 0.1	93.9	< 1
13	Field blank	DSN14SD01	< 0.1	89.6	< 1
14	Trip blank	DSN14SD01	< 0.1	<4	< 1
15	81.00	DSN14SD01	< 0.1	141	< 1
16	90.00	DSN14SD01	< 0.1	2150	< 1
17	9.00	DSN14SD02	< 0.1	784	< 1
18	18.00	DSN14SD02	< 0.1	38.3	< 1
19	27.00	DSN14SD02	< 0.1	303	< 1
20	Duplicate of no. 19	DSN14SD02	< 0.1	204	< 1
21	36.00	DSN14SD02	< 0.1	1350	< 1
22	45.00	DSN14SD02	< 0.1	1220	< 1
23	Standard	DSN14SD02	< 10	1040	< 100
24	54.00	DSN14SD02	< 0.1	131	< 1
25	63.00	DSN14SD02	< 0.1	153	< 1
26	72.00	DSN14SD02	< 0.1	555	< 1
27	81.00	DSN14SD02	< 0.1	98.5	< 1
28	90.00	DSN14SD02	< 0.1	56.2	< 1
29	99.00	DSN14SD02	< 0.1	83.5	< 1
30	Field blank	DSN14SD02	< 0.1	127	< 1
31	Trip blank	DSN14SD02	< 0.1	69.1	< 1
32	108.00	DSN14SD02	< 0.1	443	< 1
33	Drilling water	DSN14SD03	< 0.1	49.7	< 1

Field no.	Sample description/Sample depth, m	Borehole no.	ICPMS_LEACH Yb/P ug/L	ICPMS_LEACH Zn/P ug/L	ICPMS_LEACH Zr/P ug/L
34	9.00	DSN14SD03	< 0.1	412	< 1
35	18.00	DSN14SD03	< 0.1	210	< 1
36	27.00	DSN14SD03	< 0.1	451	< 1
37	Duplicate of no. 36	DSN14SD03	< 0.1	476	< 1
38	36.00	DSN14SD03	< 0.1	264	< 1
39	45.00	DSN14SD03	< 0.1	216	2.1
40	57.00	DSN14SD03	< 0.1	51.6	< 1
41	Standard	DSN14SD03	< 0.1	32.8	< 1
42	63.00	DSN14SD03	< 0.1	232	< 1
43	9.00	DSN14SD04	< 0.1	46.2	< 1
44	18.00	DSN14SD04	< 0.1	41	< 1
45	27.00	DSN14SD04	< 0.1	156	< 1
46	36.00	DSN14SD04	< 0.1	324	< 1
47	45.00	DSN14SD04	< 0.1	40.8	< 1
48	Field blank	DSN14SD04	< 0.1	24.9	< 1
49	Trip blank	DSN14SD04	< 0.1	5.8	< 1

Table 6. Estimated sediment thickness for passive seismic measurements using the horizontal to vertical spectral ratio method, Dasht-e-Nawar, Afghanistan.

[WSG84, datum; Hz, hertz; m, meter; --, could not be calculated]

Survey 1. -- 20 minute measurement window					Confidence interval based on resonance peak		
Site Identifier	Latitude (WGS84)	Longitude (WGS84)	Peak resonance frequency (Hz)	Sediment thickness (m)	Sediment thickness lower 95 percent (m)	Sediment thickness upper 95 percent (m)	Remark
A01	33.6767534	67.7396643	1.5	55.0	44.5	70.7	
A02	33.6485387	67.7367149	13.75	2.9	1.5	11.6	Poor
A06	33.5782993	67.7563959	--	--	--	--	Poor
B02	33.6526555	67.7577113	--	--	--	--	Poor
B03	33.6350954	67.7626308	0.91	106.5	83.9	142.6	
B04	33.6175347	67.7675480	2.03	36.8	30.3	46.2	
B05	33.5999738	67.7724635	--	--	--	--	Poor
B06	33.5824126	67.7773765	--	--	--	--	Poor
B07	33.5648511	67.7822874	--	--	--	--	Poor
B08	33.5472893	67.7871962	1.22	72.2	42.2	180.9	
B09	33.5297274	67.7921032	--	--	--	--	Poor
B10	33.5121648	67.7970079	1.16	77.2	58.0	111.3	
C01	33.6743300	67.7737924	1.22	72.2	--	--	
C03	33.6392077	67.7836255	1.25	70.0	3.4	--	Poor
C04	33.6216462	67.7885388	2.3	31.2	28.9	33.9	
C05	33.6040844	67.7934501	--	--	--	--	Poor
C06	33.5865224	67.7983592	--	--	--	--	Poor
C07	33.5689601	67.8032661	2.19	33.3	27.6	41.3	Poor
C08	33.5513973	67.8081710	0.94	102.0	65.7	197.9	
C09	33.5338343	67.8130740	2.3	31.2	22.2	49.2	Poor
C11	33.4987076	67.8228736	0.91	106.5	95.3	120.3	
D02	33.6608788	67.7997106	3.13	20.8	15.4	30.7	
D03	33.6439756	67.8050943	--	--	--	--	
D04	33.6257543	67.8095313	1.69	46.9	36.3	64.4	
D06	33.5906285	67.8193440	7.67	55.0	6.3	--	

Survey 1. -- 20 minute measurement window					Confidence interval based on resonance peak		
Site Identifier	Latitude (WGS84)	Longitude (WGS84)	Peak resonance frequency (Hz)	Sediment thickness (m)	Sediment thickness lower 95 percent (m)	Sediment thickness upper 95 percent (m)	Remark
D07	33.5730651	67.8242469	--	--	--	--	
D08	33.5555016	67.8291480	0.98	106.5	96.5	118.4	Poor
D09	33.5379377	67.8340469	--	--	--	--	
D10	33.5203737	67.8389436	3.13	20.8	12.9	43.8	
E03	33.6474221	67.8256208	--	--	--	--	
AOI_1	33.5170000	67.8180000	0.63	173.3	147.9	207.4	
AOI_2	33.5430000	67.7780000	2.09	35.4	30.3	42.2	
AOI_3	33.5900000	67.7830000	--	--	--	--	
AOI_4	33.6567700	67.7787000	1.56	52.2	36.8	83.9	
1	33.6506160	67.7472320	2.88	23.2	18.5	30.3	
2	33.6547320	67.7684780	1.25	70.0	63.2	78.1	
3	33.6588880	67.7897240	1.56	52.2	7.8	--	
4	33.6635630	67.8107940	1.56	52.2	41.3	69.2	
5	33.6329640	67.7516920	3.13	20.8	12.1	52.6	Poor
6	33.6368960	67.7716760	--	--	--	--	
7	33.6410670	67.7928710	--	--	--	--	
8	33.6451910	67.8140070	1.63	49.2	47.7	50.9	
9	33.6278810	67.8205730	2.91	22.9	21.2	24.7	
10	33.6193470	67.7783000	2.5	27.9	18.9	48.8	
11	33.6147440	67.7573360	--	--	--	--	
12	33.5980650	67.7610560	1.09	83.9	55.4	153.6	
13	33.5807380	67.7663360	1.44	58.0	48.1	72.2	
14	33.5493420	67.7978810	1.84	41.9	1.5	--	
15	33.5316970	67.8024890	0.88	111.3	85.9	153.6	
16	33.5355330	67.8236830	1.31	65.7	50.0	92.8	Poor
17	33.5142430	67.8072110	1.09	83.9	67.1	109.7	
18	33.5181750	67.8287510	1.84	41.9	30.5	63.8	

Survey 2. -- 30 minute measurement window					Confidence interval based on resonance peak		
Site Identifier	Latitude (WGS84)	Longitude (WGS84)	Peak resonance frequency (Hz)	Sediment thickness (m)	Sediment thickness lower 95 percent (m)	Sediment thickness upper 95 percent (m)	Remark
S1	33.639202	67.783620	--	--	--	--	
S1	33.639202	67.783620	1.84	41.9	30.5	63.8	
S2	33.621646	67.788535	2.16	33.9	27.5	43.5	
S3	33.604080	67.793448	1.3	66.4	48.8	99.2	
S4	33.586523	67.798358	1.88	40.8	31.6	55.9	
S5	33.533833	67.813066	3.5	17.9	14.1	23.8	Poor
S6	33.529725	67.792102	3.59	17.3	16.9	17.8	Poor
S7	33.542998	67.777991	--	--	--	--	
S8	33.564847	67.782283	--	--	--	--	
S9	33.520370	67.838941	--	--	--	--	
S10	33.537938	67.834043	--	--	--	--	
S11	33.573063	67.824241	0.91	106.5	88.1	132.9	Poor
S12	33.590621	67.819336	2	37.5	31.4	46.2	
S13	33.652652	67.757701	5.81	9.1	8.4	10.0	
S14	33.635088	67.762621	2.63	26.1	22.7	30.5	Poor
S15	33.617533	67.767540	1.88	40.8	35.2	48.1	
S16	33.599968	67.772457	1.38	61.4	11.6	--	
S17	33.582413	67.777371	1.25	70.0	59.6	83.9	
S18	33.547282	67.787194	4.75	11.9	10.3	14.1	Poor
S19	33.512159	67.797008	--	--	--	--	
S20	33.516997	67.817990	--	--	--	--	
S21	33.551391	67.808162	0.95	53.5	28.2	193.4	Poor
S22	33.568957	67.803256	2.88	23.2	20.4	26.7	Poor
S23	33.656767	67.778704	1.04	23.9	15.8	44.1	Poor
S24	33.660878	67.799709	3.35	40.8	19.0	306.1	Poor
S25	33.643975	67.805087	--	--	--	--	
S26	33.625754	67.809521	--	--	--	--	
S27	33.589999	67.782997	1.76	87.0	44.5	363.6	
S28	33.555496	67.829143	6.43	9.5	8.0	11.7	Poor

Appendix 1

Appendix 1a. Description of borehole DSN14SD01 core, Dasht-e-Nawar, Afghanistan.

Dasht-e-Nawar Lithium Deposit Geological Logging Sheet

Hole ID:	DSN-001	Date :	23-Sep-14	Sheet 1	Geologist : Ahmad Qasim, Mohammad Idrees, Ghulam Nabi and Abdul Khaliq

Row	From (cm)	Row	To (cm)	Core size	Box no.	Lithology	Color	Comments
1	0	3	10	NQ	1	Silt	Light tan	It changes from light tan to tan
3	10	5	80	NQ	1	Silt	Dark gray	
5	80	3	10	NQ	1 up to 2	Silt	Very light gray	In box 2 Row 2 from 30–70 cm the color change to tan
3	10	3	100	NQ	2 up to 3	Silt	Dark gray	The color changes in many parts from light gray to gray
4	0	5	100	NQ	3	Slit	Tan	
1	0	1	38	NQ	4	Clay	Light gray	This zone has a low percentage of sand, maybe 3 percent or less
1	38	1	87	NQ	4	Clay	Dark gray	Some shell fragments can be seen
1	87	3	10	NQ	4	Silt	Tan	In the first 10cm a fossil is observed
3	10	5	100	NQ	4	Clay	Tan	
1	0	3	30	NQ	5	Silt	Light gray	Light gray in the middle and tan in sides of core
3	30	3	90	NQ	5	Clay	Dark tan	Calcium has increased in some parts
3	90	3	100	NQ	6	Slit	Light	At the row 3 of this box the grains are coarser
4	0	2	20	NQ	6 up to 7	Silt	Dark tan	
2	20	5	85	NQ	7 up to 8	Clay	Tan to dark gray	The color changes from tan to dark gray
5	85	5	100	NQ	8 up to 9	Silt	Tan	Some shell fragments at 30.8 m and throughout the zone. The color changes from tan to dark and light gray
1	0	2	40	NQ	10	Clay	Gray to light gray light tan	
2	40	4	40	NQ	10	Silt	Dark tan	At 32.80 m some small dark minerals or heavy minerals
4	40	4	95	NQ	10	Clay	Dark tan	
4	95	5	100	NQ	10	Fine grained sand	Tan to brown	
1	0	1	60	NQ	11 up to 13	Silt	Light gray to dark gray	Some shell fragments were observed at 37 m
1	60	2	100	NQ	13	Fine grained sand	Dark gray	
3	0	4	75	NQ	13	Clay	Dark tan	

Dasht-e-Nawar Lithium Deposit Geological Logging Sheet

Hole ID: DSN-001 Date: 23-Sep-14 Sheet 2 Geologist : Ahmad Qasim, Mohammad Idrees, Ghulam Nabi and Abdul Khaliq

Row	From (cm)	Row	To (cm)	Core size	Box no.	Lithology	Color	Comments
4	75	1	35	NQ	14 up to 15	Silt	Gray to dark gray	Shell fragments at n 51.8 m and in some parts it is gray to dark gray
1	35	1	100	NQ	15	Clay	Light gray	
2	0	2	100	NQ	15	Clay	Light gray	Clay mixed with calcium and it is cemented similar to a small size conglomerate
3	0	3	15	NQ	15 up to 16	Silt	Light tan to light gray	
3	15	5	80	NQ	16	Clay	Tan	
5	80	1	65	NQ	16 up to 17	Fine grained sand	Tan	
1	65	3	65	NQ	17	Silt	Light gray	
3	65	2	10	NQ	17 up to 18	Sand	Light gray to tan	At the beginning of this unit is coarse grained sand and it changes to fine grained clay sand
2	10	3	90	NQ	18	Clay	Light gray to light tan	
3	90	4	20	NQ	18	Silt	Gray	
4	20	4	85	NQ	18	Medium grained sand	Gray	
4	85	5	30	NQ	18 up to 19	Silt	Tan	
1	30	1	50	NQ	19	Conglomerate	Gray	Conglomerate of quartz observed
1	50	3	10	NQ	19	Silt	Tan	
3	10	1	10	NQ	19 up to 20	Clay	Tan to gray to tan	
1	10	1	50	NQ	20	Coarse grained sand	Tan	
1	50	1	50	NQ	20 up to 21	Clay	Light gray	

Dasht-e-Nawar Lithium Deposit Geological Logging Sheet

Hole ID: DSN-001 Date: 23-Sep-14 Sheet 3 Geologist : Ahmad Qasim, Mohammad Idrees, Ghulam Nabi and Abdul Khaliq

Row	From (cm)	Row	To (cm)	Core size	Box no.	Lithology	Color	Comments
1	50	3	30	NQ	21	Fine grained sand	Gray to tan	
3	30	End of hole		NQ	21	Silt	Light gray	

Appendix 1b. Description of borehole DSN14SD02 core, Dasht-e-Nawar, Afghanistan.

Dasht-e-Nawar Lithium Deposit Geological Logging Sheet

Hole ID: DSN-002 Date: 24-Sep-14 Sheet: 1 Geologist : Ahmad Qasim, Mohammad Idrees and Ghulam Nabi

Row	From (cm)	Row	To (cm)	Core size	Box no.	Lithology	Color	Comments
1	0	2	90	NQ	1 up to 4	Clay	Tan to gray	From 3m up to 4m plant roots observed
2	90	1	90	NQ	4 up to 5	Silt	Light tan	21m to 22m, 24m to 25m, 28m to 29m, Plant roots with brown Color, 31m to 33m brown shapes possibly plant roots
1	90	2	50	NQ	5 up to 8	Clay	Tan to light and dark gray	
2	50	4	60	NQ	8	Silt	Gray	
4	60	2	80	NQ	8 up to 10	Clay	Gray	41m to 41.8m clay mixed with a lot of calcium and in Row 3 - 25cm observed calcium in the clay and conglomerate grains
2	80	3	100	NQ	10	Clay	Dark gray	Biotite-Muscovite Mineralization; Foraminifera fossil. AGS chemical analysis found K = 0.59ppm, Ca = 7.69ppm, Sc = 1.13ppm, Ti = 0.16ppm, Fe = 4.28ppm, Cd = 6.41ppm
4	00	2	40	NQ	10 up to 12	Clay	Dark gray	Box#10 Row 4 - 43cm a black spot with brown radius was observed and smells like H_2SO_4, In Box 11 Row 1 the clay has a conglomeratic texture with white grains and its all clay
2	40	3	20	NQ	12	Silt	Light gray	
20	20	3	66	NQ	12 up to 14	Clay	Gray	
3	66	5	10	NQ	14	Clay	Very light gray	Box#14 Row 5 – 10 cm light color clay with gray layers
5	10	1	84	NQ	14 up to 15	Silt	Light gray	
1	84	1	34	NQ	15 up to 18	Clay	Tan to gray	Brown color is visible in core from 76 m up to 84 m
1	34	2	63	NQ	18 up to 19	Silt	Light gray	
2	63	End of hole		NQ	19 up to 22	Clay	Light gray to dark gray to light gray	Along the section some brown spots can be seen

Appendix 1c. Description of borehole DSN14SD03 core, Dasht-e-Nawar, Afghanistan

Dasht-e-Nawar Lithium Deposit Geological Logging Sheet

Hole ID:	DSN-003	Date:	27-Sep-14	Sheet 1	Geologist: Ahmad Qasim, Mohammad Idrees, Ghulam Nabi and Abdul Khaliq

Row	From (cm)	Row	To (cm)	Core size	Box no.	Lithology	Color	Comments
1	0	1	70	NQ	1	Clay	Dark gray	
1	70	2	65	NQ	1 up to 3	Silt	Gray	Along this zone some layers of clay and in the clay layer some black spots, which smell like H_2SO_4.
2	65	2	100	NQ	3 up to 4	Clay	Dark gray	Along this zone some black and brownish spots which smell like H2SO4 were observed.
2	100	4	37	NQ	4 up to 8	Silt	Sequence of color	Box#4 row 3 - 85 cm, row4 – 35 cm, and Box#7 row 2 – 30 cm plant roots from Box#4 up to Box#8 the color changes from dark gray to light gray in this zone
4	37	End of hole		NQ	8	Clay	Dark gray	
				NQ				

Appendix 1d. Description of borehole DSN14SD04 core, Dasht-e-Nawar, Afghanistan.

Dasht-e-Nawar Lithium Deposit Geological Logging Sheet								
Hole ID:	DSN-004		Date:	27-Sep-14			Sheet 1	Geologist: Ahmad Qasim, Mohammad Idrees and Ghulam Nabi
Row	From (cm)	Row	To (cm)	Core size	Box no.	Lithology	Color	Comments
1	0	2	45	NQ	1	Very fine grain sand	Light gray	
2	45	2	90	NQ	1	Silt	Tan	
2	90	3	12	NQ	1	Clay	Gray	
3	12	2	25	NQ	1 up to 2	Very fine grain sand	Dark gray to tan	Sandy clay
2	25	3	60	NQ	2	Silt	Light gray	Approximately at 8 m shell fragments were observed
3	60	1	75	NQ	2 up to 3	Very fine grain sand	Gray to dark tan	
1	75	3	45	NQ	3	Medium grain sand	Light tan	
3	45	1	65	NQ	3 up to 4	Silt	Gray	
1	65	2	30	NQ	4	Medium grain sand	Tan	
2	30	3	10	NQ	4	Clay	Dark gray	
3	10	3	30	NQ	4	Sand	Gray	
3	30	5	100	NQ	4	Clay	Dark gray to tan	
1	00	1	45	NQ	5	Fine grain sand	Tan	
1	45	1	75	NQ	5	Silt	Tan	
1	75	2	18	NQ	5	Clay	Dark gray	
2	18	2	52	NQ	5	Silt	Gray	
2	52	2	100	NQ	5	Very fine grain sand	Light gray	
3	00	3	68	NQ	5	Silt	Light gray	
3	68	3	68	NQ	5	Clay	Dark gray	Some shell fragments were observed in some area
3	68	3	100	NQ	5	Sand	Tan	
4	00	5	70	NQ	5	Clay	Tan	
5	70	1	100	NQ	5 up to 6	Very fine grain sand	Tan	

Dasht-e-Nawar Lithium Deposit Geological Logging Sheet

Hole ID: DSN-004 Date: 27-Sep-14 Sheet 2 Geologist: Ahmad Qasim, Mohammad Idrees and Ghulam Nabi

Row	From (cm)	Row	To (cm)	Core Size	Box No	Lithology	Color	Comments
2	0	4	100	NQ	6	Sand	Dark tan	Sand mixed with clay
5	0	5	60	NQ	6	Silt	Light tan	
5	60	3	20	NQ	6 up to 7	Medium grain conglomerate	Tan	Conglomeratic sand
3	20	4	5	NQ	7 up to 8	Very fine grain sand	Tan	In this zone some coarser grains of sand were observed.
4	5	End of hole		NQ	8	Sand	Tan	Medium grained, fine grained and medium grained size sand
End of hole				NQ				

Appendix 1e. Description of borehole DSN14SD05 core, Dasht-e-Nawar, Afghanistan.

Dasht-e-Nawar Lithium Deposit Geological Logging Sheet

Hole ID: DSN-005 Date: 27-Sep-14 Sheet 1 Geologist: Ahmad Qasim, Mohammad Idrees, Ghulam Nabi and Abdul Khaliq

Row	From (cm)	Row	To (cm)	Core size	Box no.	Lithology	Color	Comments
1	0	1	25	NQ	1	Silt	Tan	
1	25	1	35	NQ	1	Clay	Dark tan	
1	35	1	60	NQ	1	Silt	Tan	
1	60	4	100	NQ	1 up to 2	Clay	Light gray to tan	In some area plant roots are visible.
5	0	2	25	NQ	2	Silt	Gray	Silt mixed with clay and in some areas shell fragments are observed.
2	25	2	95	NQ	2	Clay	Dark gray	
2	95	3	30	NQ	2	Silt	Gray	
3	30	3	95	NQ	2	Clay	Dark gray	Some brown layers in some areas are visible.
3	95	4	35	NQ	2	Silt	Gray	
4	35	4	100	NQ	2	Clay	Dark gray	
5	0	5	35	NQ	2	Silt	Gray	
5	35	5	90	NQ	2	Clay	Gray	
5	90	2	30	NQ	3	Silt	Dark gray	
2	30	3	55	NQ	3	Clay	Light gray	
3	55	3	30	NQ	5	Silt	Light gray	In some place the blue layer and dark layers are visible, also along this zone there are some color changes.
3	30	5	100	NQ	5	Clay	Gray	
1	0	4	15	NQ	6	Silt	Dark gray	
4	15	5	100	NQ	6	Clay	Dark gray	
5	100	End of hole		NQ				

Appendix 1f. Description of borehole DSN14SD06 core, Dasht-e-Nawar, Afghanistan.

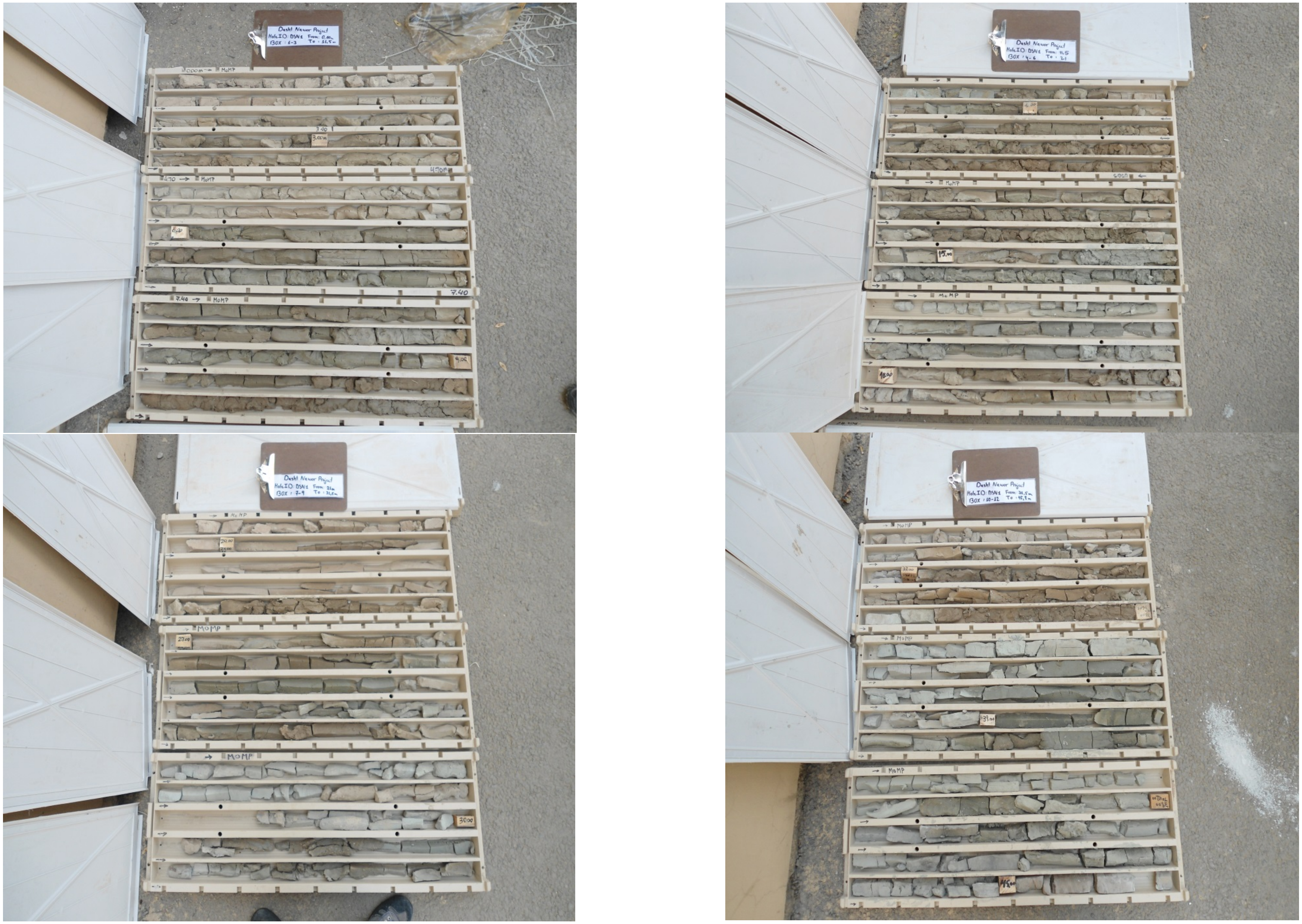
Dasht-e-Nawar Lithium Deposit Geological Logging Sheet

Hole ID:	DSN-006	Date:	27-Sep-14	Sheet 1	Geologist: Ahmad Qasim, Mohammad Idrees, Ghulam Nabi and Abdul Khaliq

Row	From (cm)	Row	To (cm)	Core size	Box no.	Lithology	Color	Comments
1	0	1	80	NQ	1 up to 3	Clay	Gray	Brown color layers up to 6m
1	80	3	8	NQ	3 up to 4	Silt	Light gray	The color changes from gray to light gray.
3	8	5	80	NQ	4	Clay	Dark tan	Some brown layers is visible along the zone.
5	80	2	10	NQ	4 up to 5	Silt	Tan to dark tan	Banded color and the at end of zone the color changes to gray.
2	10	1	70	NQ	5 up to 7	Clay	Dark gray	From 27m up to 28.5m are some black spots and the core has H_2SO_4 smell.
1	70	End of hole		NQ	7 up to 8	Silt	Dark gray to gray	In box #8, row 4 - from 00cm to 50cm clay zone is visible with light gray color.
				NQ				

Appendix 2

Appendix 2a. Photographic log of borehole DSN14SC01 core, Dasht-e-Nawar, Afghanistan.



Appendix 2a. DSN14SC01 core continued.

Appendix 2b. Photographic log of borehole DSN14SD02 core, Dasht-e-Nawar, Afghanistan.

Appendix 2b. DSN14SD02 core continued.

Appendix 2c. Photographic log of borehole DSN14SD03 core, Dasht-e-Nawar, Afghanistan.

Appendix 2d. Photographic log of borehole DSN14SD04 core, Dasht-e-Nawar, Afghanistan.

Appendix 2e. Photographic log of borehole DSN14SD05 core, Dasht-e-Nawar, Afghanistan.

Appendix 2f. Photographic log of borehole DSN14SD06 core, Dasht-e Nawar, Afghanistan.