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SHALLO-TEMP<sup>®</sup> SURVEYS AS A POTENTIAL GUIDE TO BIDDING FOR GEOTHERMAL LEASES:  
A CASE HISTORY AT COSO

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Abstract

In this paper we examine the results of the September 1981 Bureau of Land Management lease sale at the Coso KGRA in California. Parcels available for leasing were included in the Naval Weapons Center area (NWC) as well as in adjacent areas to the south and west. The bidders presumably based their offers on the geological and geophysical survey data that were available in the public domain for the NWC area. Since some \$5 million were bid for parcels in the adjacent area to the south and west, it is suspected that trends hinted at by the public domain data may have influenced companies to bid in this adjacent region. Among the data publicly available was a SHALLO-TEMP<sup>®</sup> survey, the interpretation of which was consistent with other independent surveys that pointed to a favorable geothermal resource in the NWC area. Prior to the bidding, an inexpensive but heretofore proprietary SHALLO-TEMP<sup>®</sup> survey was conducted on the adjacent lands to the west and tied in with the original public domain survey. From a similar interpretation of the proprietary survey, whose results are divulged here, we conclude that the bidding might have been significantly different in the adjacent area to the west had these new data been considered.

Introduction

This paper discusses the results of a "what would you bid" exercise that LeSchack Associates, Ltd. conducted in-house based on SHALLO-TEMP<sup>®</sup> survey data (LeSchack and Lewis, 1983) that were collected at the Coso KGRA. We believe these results will be of interest to those involved in the lease bidding process, whether in industry or in government. Basically, this study is an exercise in hindsight, since we already had survey data over essentially all of the land for which the Bureau of Land Management (BLM) accepted bids on 15 September 1981. Half of our data, collected and analyzed under a Department of Energy Contract, were in the public domain well before bidding started (LeSchack, et al. 1977, 1979, 1980). The other half of our data were collected in 1979 on speculation in the western portion of the KGRA and were proprietary to us. These new data are now disclosed in this paper to illustrate our exercise, and to give others an opportunity to judge for

themselves whether they would make the same bidding decisions as were made if they had access to our inexpensively obtained data, or whether they would have made other decisions.

The SHALLO-TEMP<sup>®</sup> Survey

As was described by LeSchack and Lewis (1983), the SHALLO-TEMP<sup>®</sup> survey is an inexpensive and rapid "first look" geophysical technique that is useful in planning the more traditional and costly reconnaissance drilling geothermal exploration programs. The technique is based on making many soil temperature measurements at 2-m depths over a given exploration area and correcting these measurements for the effects of elevation and surface geologic and meteorologic conditions. Corrections for surface conditions are made with an "annual wave correction model." The output from the model is the normally expected 2-m temperature for the given site at the date for which input data were provided. The difference between the measured and computed 2-m temperature data represents effects of geothermal heat flow.

Case history studies at Coso, California, Upsal Hogback in Nevada, and Animas Valley in New Mexico provided evidence to support the applicability of the SHALLO-TEMP<sup>®</sup> technique throughout the Basin and Range Province. The technique developed is not designed to replace reconnaissance drilling but rather help focus standard reconnaissance programs. LeSchack and Lewis (1983) concluded that the two most reliable applications of the technique are in extending trends where standard reconnaissance holes have been drilled or filling in detail between widely spaced holes, and in surveying for near-surface anomalies that might be developed for direct heating applications.

Our exercise presented here involves application of the SHALLO-TEMP<sup>®</sup> survey to extend trends already observed at the Coso KGRA.

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## Our Surveys at the Coso KGRA

In 1977 we conducted a SHALLO-TEMP<sup>A</sup> survey on that portion of the Coso KGRA that lies within the boundaries of the U.S. Naval Weapons Center (LeSchack, et al 1977). This survey duplicated the temperature anomaly patterns of a standard reconnaissance survey to a depth of 30 m made by Combs (1975, 1976), as well as confirmed the aeromagnetic and resistance surveys conducted by the University of Utah (Fox, 1978 a, b; Hulen, 1978). The 2-m anomaly map developed at the Naval Weapons Center area is shown in Figure 1. The generalized hydrothermal alteration and geophysical map developed from University of Utah studies is shown in Figure 2. After studying the temperature anomaly patterns shown in Figure 1, and the complementary surveys shown in Figure 2, we became interested in determining whether the trend displayed in those Figures continued to the northwest of the original survey site outside of the Naval Reservation boundaries as hinted by the contours shown in Figure 1, or to the southwest as a continuation of the "belt of active thermal phenomena" shown in Figure 2. Accordingly, on a speculative basis, we conducted a similar but proprietary SHALLO-TEMP<sup>B</sup> survey in the area to the west of Figure 1 and tied it to the original survey already in the public domain.

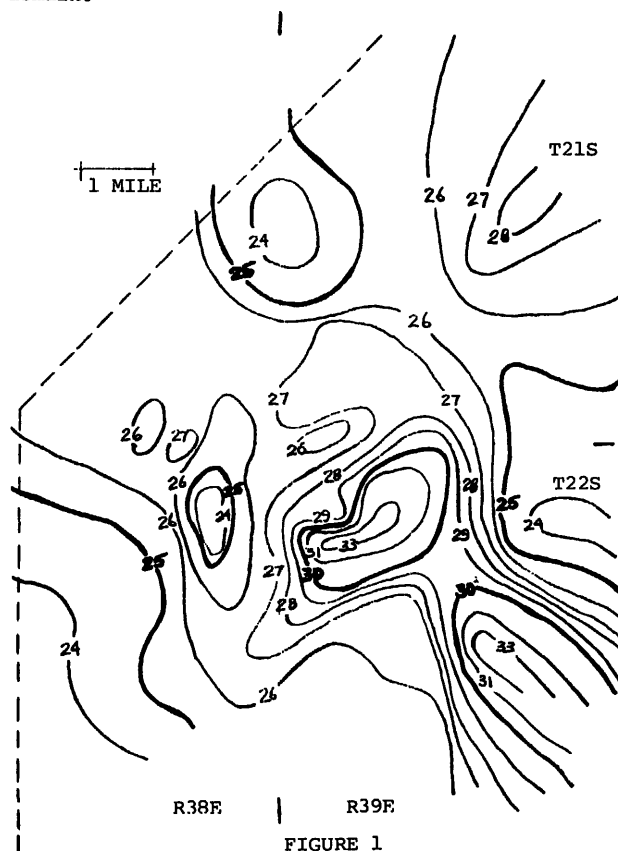


FIGURE 1  
2-M TEMPERATURE CONTOUR MAP FOR COSO  
(NAVAL WEAPONS CENTER AREA),  
SEPTEMBER 1977. TEMPERATURE IN °C.

## Parcels Offered for Bid

Notice was given by the BLM (1981) that 28 parcels totalling 60,862.78 acres, within the Coso KGRA were offered for geothermal leasing through sealed bids to the responsible qualified bidders of the highest cash bonus for the privilege of leasing. All the bids had to have been received by the BLM in Sacramento, California by 15 September 1981. The parcels are listed in Table 1 (Parcels 1-3, and 11 are not shown because they were withdrawn). Bidders probably had to base their decisions essentially on the public domain information, summarized in Figure 2, as well as the then known, but inconclusive results of deep drilling a mile north of Devil's Kitchen.

When the parcels listed in Table 1 are plotted on the Haiwee Reservoir and Little Lake, California 15-minute Quadrangles, it can be seen that an additional area, essentially equal in size to that shown in Figure 1, was included in the lease sale. This additional area is to the south and west of the area covered in Figures 1 and 2.

Based on the information available, and represented in Figures 1 and 2 only, we would have been inclined to gamble that useful prospects that were open for bids extended either to the northwest or southwest. Obviously others felt the same way, as demonstrated in Table 2, the summary list of bidders published by BLM. Millions of dollars were bid for rights in areas just outside of that shown in Figures 1 and 2. Based on the information available to this point, how would you have bid?

TABLE 1  
PARCELS OFFERED BY BLM

PARCEL NO. 4	2,553.44 acres
T. 21 S., R. 39 E., Sec. 19, lots 1 to 4, inclusive, E 1/2, E 1/2 W 1/2; Secs. 20 and 29; Sec. 30, lots 1 to 4, inclusive, E 1/2, E 1/2 W 1/2.	
PARCEL NO. 5	1,920.00 acres
T. 21 S., R. 39 E., Sec. 21; Sec. 22, W 1/2; Sec. 27, W 1/2; Sec. 28.	
PARCEL NO. 6	2,471.18 acres
T. 21 S., R. 37 E., Secs. 27 and 34; Sec. 35, W 1/2.	
T. 22 S., R. 37 E., Sec. 2, lots 1 and 2 of NW 1/4, SW 1/4; Sec. 3, lots 1 and 2 of NE 1/4; lots 1 and 2 of NW 1/4, E 1/2 SW 1/4, SE 1/4.	
PARCEL NO. 7	2,394.38 acres
T. 21 S., R. 37 E., Sec. 35, E 1/2; Sec. 36.	
T. 22 S., R. 37 E., Sec. 1, lots 1 and 2 of NE 1/4, lots 1 and 2 of NW 1/4, S 1/2; Sec. 2, lots 1 and 2 of NE 1/4; Sec. 12.	
PARCEL NO. 8	2,579.95 acres
T. 21 S., R. 38 E., Sec. 29; Sec. 30, lots 1 to 4, inclusive, E 1/2, E 1/2 W 1/2; Sec. 31, lots 5 to 16, inclusive, NE 1/4; Sec. 32, lots 1 to 8, inclusive, N 1/2.	

TABLE 1

## PARCELS OFFERED BY BLM (CONTINUED)

PARCEL NO. 9	2,697.84 acres
T. 22 S., R. 38 E., Sec. 5, lots 3 to 18, inclusive; Sec. 6, lots 3 to 14, inclusive; Sec. 8, lots 1 to 16, inclusive; Sec. 17, lots 1 to 16, inclusive.	
PARCEL NO. 10	1,920.99 acres
T. 21 S., R. 38 E., Sec. 33.	
T. 22 S., R. 38 E., Sec. 4, lots 3 to 8, inclusive, S 1/2 NE 1/4, S 1/2; Sec. 9.	
PARCEL NO. 12	2,430.95 acres
T. 21 S., R. 38 E., Sec. 36.	
T. 22 S., R. 38 E., Sec. 1, lots 1 to 4, inclusive, S 1/2 N 1/2, S 1/2.	
T. 21 S., R. 39 E., Sec. 31, lots 1 to 4, inclusive, E 1/2, E 1/2 W 1/2.	
T. 22 S., R. 39 E., Sec. 6, lots 1 to 7, inclusive, S 1/2 NE 1/4, SE 1/4 NW 1/4, NE 1/4 SW 1/4, N 1/2 SE 1/4.	
PARCEL NO. 13	1,839.32 acres
T. 21 S., R. 39 E., Sec. 32; Sec. 33, N 1/2, N 1/2 S 1/2, S 1/2 SW 1/4, SW 1/4 SE 1/4.	
T. 22 S., R. 39 E., Sec. 4, lots 2, 3, and 4; Sec. 5, lots 1 to 4, inclusive, S 1/2 N 1/2, N 1/2 S 1/2.	
PARCEL NO. 14	1,920.00 acres
T. 22 S., R. 38 E., Sec. 10; Sec. 11, W 1/2; Sec. 14, W 1/2; Sec. 15.	
PARCEL NO. 15	2,555.00 acres
T. 22 S., R. 38 E., Sec. 11, E 1/2; Secs. 12 and 13; Sec. 14, E 1/2.	
T. 22 S., R. 39 E., Sec. 7, lots 1 to 4, inclusive, E 1/2 W 1/2; Sec. 18, lots 1 to 4, inclusive, E 1/2 W 1/2.	
PARCEL NO. 16	1,040.00 acres
T. 22 S., R. 37 E., Sec. 25, N 1/2, N 1/2 S 1/2, SW 1/4 SW 1/4, SE 1/4 SE 1/4; Sec. 36, E 1/2 NE 1/4, W 1/2 NW 1/4, S 1/2.	
PARCEL NO. 17	2,274.32 acres
T. 22 S., R. 38 E., Sec. 19, lots 3 to 8, inclusive, SE 1/4; Sec. 20, N 1/2, N 1/2 S 1/2, SE 1/4 SW 1/4, S 1/2 SE 1/4; Sec. 29; Sec. 30, lots 3 to 10, inclusive, E 1/2.	
PARCEL NO. 18	2,560.00 acres
T. 22 S., R. 38 E., Secs. 21, 22, 27, and 28.	
PARCEL NO. 19	2,560.00 acres
T. 22 S., R. 38 E., Secs. 23, 24, 25, and 26.	
PARCEL NO. 20	2,554.04 acres
T. 22 S., R. 39 E., Sec. 19, lots 1 to 4, inclusive, E 1/2, E 1/2 W 1/2; Secs. 20 and 29; Sec. 30, lots 1 to 4, inclusive, E 1/2, E 1/2 W 1/2, 1/2 W 1/2.	
PARCEL NO. 21	1,440.00 acres
T. 22 S., R. 39 E., Sec. 21; Sec. 22, W 1/2; Sec. 28, N 1/2, SW 1/4.	

TABLE 1

## PARCELS OFFERED BY BLM (CONTINUED)

PARCEL NO. 22	1,835.05 acres
T. 22 S., R. 38 E., Sec. 31, lots 3 to 10, inclusive, E 1/2; Sec. 32.	
T. 23 S., R. 38 E., Sec. 5, lots 1 to 4, inclusive, S 1/2 N 1/2, E 1/2 SW 1/4, SE 1/4.	
PARCEL NO. 23	2,564.16 acres
T. 22 S., R. 38 E., Secs. 33 and 34.	
T. 23 S., R. 38 E., Sec. 3, lots 1 to 4, inclusive, S 1/2 N 1/2, S 1/2; Sec. 4, lots 1 to 4, inclusive, S 1/2 N 1/2, S 1/2.	
PARCEL NO. 24	2,562.48 acres
T. 22 S., R. 38 E., Secs. 35 and 36.	
T. 23 S., R. 38 E., Sec. 1, lots 1 to 4, inclusive, S 1/2 N 1/2, S 1/2; Sec. 2, lots 1 to 4, inclusive, S 1/2 N 1/2, S 1/2.	
PARCEL NO. 25	2,566.12 acres
T. 22 S., R. 39 E., Sec. 31, lots 1 to 4, inclusive, E 1/2, E 1/2 W 1/2; Sec. 32.	
T. 23 S., R. 39 E., Sec. 5, lots 1 to 4, inclusive, S 1/2 N 1/2, S 1/2; Sec. 6, lots 1 to 7, inclusive, S 1/2 NE 1/4, SE 1/4 NW 1/4, E 1/2 SW 1/4, SE 1/4.	
PARCEL NO. 26	1,440.00 acres
T. 22 S., R. 39 E., Sec. 27, W 1/2; Sec. 28, SE 1/4; Sec. 33; Sec. 34, W 1/2.	
PARCEL NO. 27	1,600.00 acres
T. 23 S., R. 38 E., Secs. 9 and 10; Sec. 11, W 1/2.	
PARCEL NO. 28	1,604.32 acres
T. 23 S., R. 38 E., Sec. 11, E 1/2; Sec. 12.	
T. 23 S., R. 39 E., Sec. 7, lots 1 to 4, inclusive, E 1/2, E 1/2 W 1/2.	

Our Pre-Bid Survey

Since our SHALLO-TEMP<sup>®</sup> survey coincided so well with the independent surveys shown in Figure 2, we felt safe in using it to extend trends that had been redundantly outlined in the Figure 2 area. Accordingly, we decided on our own to investigate, prior to the lease sale, whether indeed suggested trends extended beyond that area. We tied our new survey to the published SHALLO-TEMP<sup>®</sup> survey and prepared the contour map shown in Figure 3.

From our examination of the composite survey, and bearing in mind how well our original survey was complemented by other independent surveys, we made the following interpretation based

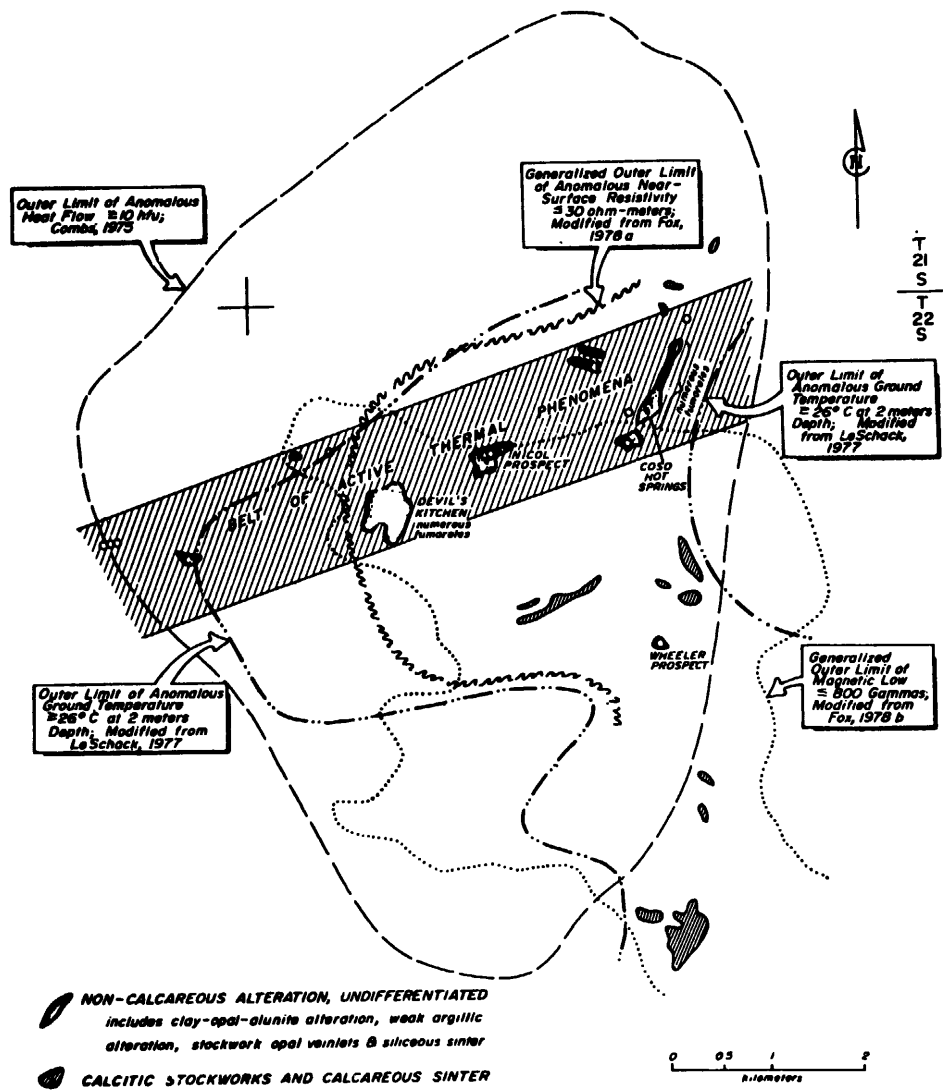


FIGURE 2  
 GENERALIZED ALTERATION AND GEOPHYSICAL MAP OF COSO  
 (AFTER HULEN, 1978).

on anomalous 2-m temperature patterns: in the lease sale areas open for bidding, only those essentially within the confines of R39E, T21S and T22S held promise. This appeared to be corroborated when in 1979, the Department of Energy, as part of their uranium survey program, drilled a

deep hole in our new survey area and found no anomalous temperatures. On the other hand, within the confines of the promising area, ongoing commercial exploration has brought in six wells that are producing an abundant supply of high quality geothermal fluids and dry steam from a steam zone at a depth of 450 m (Evans 1982).

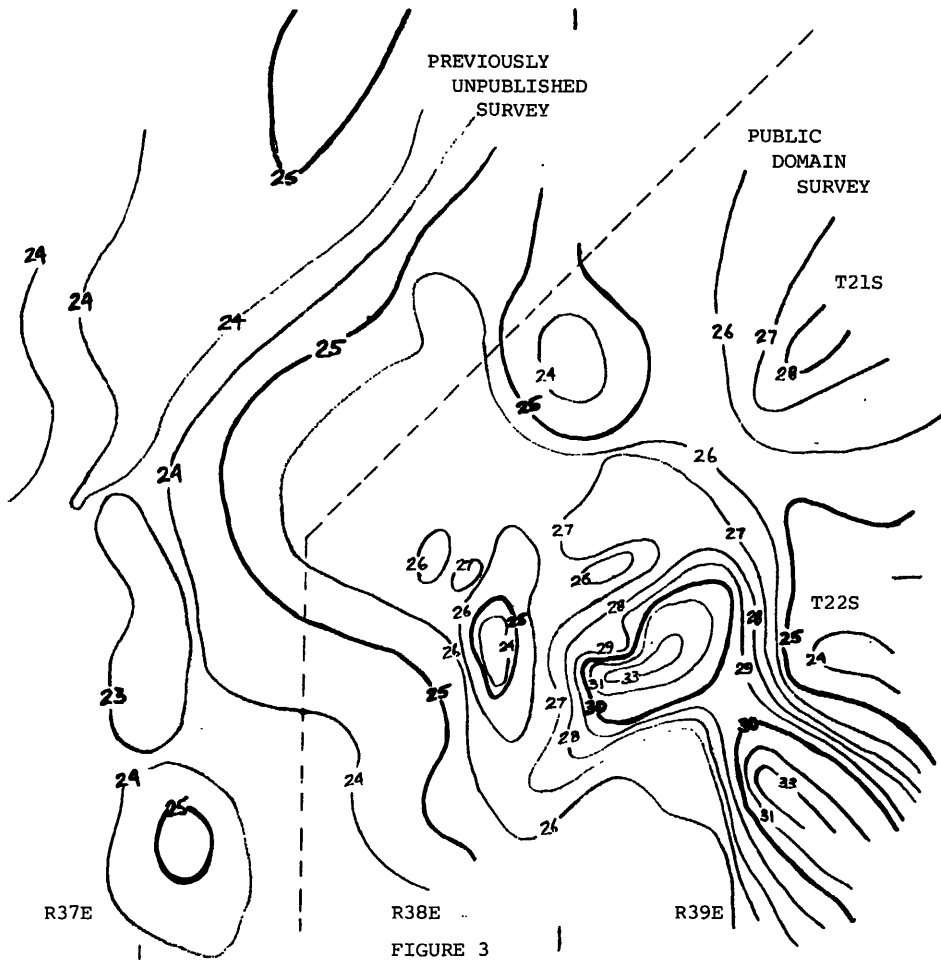


FIGURE 3

2-M TEMPERATURE CONTOUR MAP FOR COSO. UNPUBLISHED SURVEY MADE IN THE FALL OF 1979 WAS TIED IN WITH COMMON POINTS OF PUBLIC DOMAIN SURVEY TO PRODUCE FINAL SURVEY. TEMPERATURE IN °C.

TABLE 2  
BLM BID SUMMARY

COSO KGRA Sale of September 15, 1981				Parcel No.	Acreage	Amount of Total Bid	Amount of Bid per Acre
4	2,553.44	22,163.86	8.65	15	2,555.00	3,224,410.00	1,262.00
5	No Bids					812,490.00	318.00
6	No Bids			16	1,040.00	564,777.10	213.22
7	No Bids			17	2,274.32	110,452.65	43.23
8	2,579.95	10,319.80	4.00	18	2,560.00	81,760.00	32.00
9	2,697.84	34,451.42	12.77	19	2,560.00	75,000.00	29.35
10	1,920.99	17,288.91	9.00	20	2,554.04	22,500.00	8.81
10		3,938.03	2.05			133,321.00	52.20
12	2,430.95	1,366,193.90	562.00	21	1,440.00	79,205.00	31.01
		773,058.00	318.01	21		36,526.49	14.30
		65,635.65	27.00	22	1,835.05	7,502.40	5.21
		32,750.00	13.47	22		1,522.00	1.05
13	1,839.32	1,861,391.80	1,012.00	23	2,564.16	31,195.85	17.00
		426,880.00	232.10	24	2,562.48	15,641.38	6.10
		95,883.75	52.13	25	2,562.48	2,690.60	1.05
		11,500.00	6.25	26	2,566.12	2,694.43	1.05
		1,931.29	1.05	27	1,440.00	1,512.00	1.05
14	1,920.00	30,988.80	16.14	28	1,600.00	1,680.00	1.05
		23,808.00	12.40		1,604.32	1,684.54	1.05

NOTE: IF MORE THAN ONE BIDDER, HIGH BID IS UNDERLINED

Conclusions

Our conclusion is more of a business nature than purely scientific, and we recognize that bidders will never obtain all the data that they want prior to tendering their bids. But this is the nature of the exploration business. In our non-promising area \$4,846,820.01 in high bids were accepted on 31,100.74 acres with a total of 9 bidders competing. We conclude that they might have bid differently with the benefit of the additional SHALLO-TEMP survey information that we collected. Would you have bid differently? The cost of the proprietary survey was \$25,000.

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