SUMMARY OF NEW FINDINGS FROM SEISMIC OBSERVATIONS AT ABYDOS

Shelton S. Alexander, PhD, PG
Geosciences, Penn State University
University Park, PA 16801

Seismic surveys carried out in May 2007 at Abydos have revealed several important new results for the site. Seismic lines were run in the court areas in front of the Seti I temple and four deployments on the surface of the Osireion were completed, all with multiple source points. Described below are key results from these surveys showing (1) a trough in the water table running from the temple down to the entrance level, (2) a systematic reflection from the base of the Osireion indicating a depth of approximately 15 m, and (3) variability in signal waveforms from placing sources at different positions on the Osirieon indicating that its interior is very heterogeneous, not a solid block of sandstone.

Figure 1 shows a general view of the Seti I temple with courts in front and the Osireion in back. Figure 2 shows the locations of seismic lines that were run in the courtyards and at the base near the entrance (Line 1). Along each line 24 geophones were deployed at a uniform spacing and seismic sources were used at both ends of each line, indicated by A and B, respectively, as shown in Figure 2. The resulting ground motions were recorded digitally with a Strataview seismograph.

Figure 3 shows the resulting record section for Line 5 shown in Figure 2. The left panel is for the source at A and the right panel is for the source at B. The ground motion recording of each of the 24 geophones is shown in each panel, with time in msec increasing downward. The arrows show the approximate center of a trough in the groundwater surface beneath this line. The times of the first signal arrivals were used to determine the depth of the water table as shown in Figure 4. A prominent trough of approximately 1 m depth is located near the middle of the profile as shown by the arrows in Figure 3. There are indications from the recordings in Figure 3 that there is a deeper horizon beneath the tough possibly corresponding the solid base of a channel extending towards the Nile from the Seti I temple; further analysis will be needed to characterize this horizon, however.

Figure 5 shows the record section for Line 3 shown in Figure 2. The left panel shows the recordings for the source at A and the right panel is for the source at B. The arrows show the approximate center of a trough in the groundwater surface beneath this line. As along Line 5, there is a prominent trough in the water table shown in Figure 6 near the center of the profile, based on the interpretation of the first signal arrivals in Figure 5. There are also indications from these recordings that there is a deeper horizon present beneath the trough, possibly the solid base of a channel. Note that the measured depth of

the Roman well between Lines 2 and 3 (Figure 2) is about 6 m and the seismic depth nearby in Figure 6 agrees well with this measured depth. Analysis of the data for the other lines shown in Figure 2 provide further evidence of the presence of a trough extending down from the Seti I temple towards the Nile River.

Figure 7 shows a plan view of the Osirieon. Recordings were made for a series of four different deployments of sensors and sources placed on the surface of the central Osirieon (F in Figure 7). However, the surface was covered with several centimeters of water, complicating the deployment of sensors to record motions on the surface. For each configuration of sensors a number of source points were used to investigate the interior. One of these configurations is the line shown (arrows) in Figure 7. Eight sensors were used and sources placed at the end and between each sensor. Figure 8 shows the recordings for three different source positions along this line. (Note that channels 1-4 were malfunctioning because of water infiltration into the sensors and were not used in the interpretation.) The signal levels and waveforms vary significantly as the source is moved approximately 1 m along the line. Figure 9 shows recordings for additional source points along this line. Again there is a large variability in signal waveform and level as the source location is changed. On a number of channels there is a clear and consistent delayed signal arriving at approximately 19 msec, which may be a reflection from the base of the Osirieon. The onsets of some of these later arrivals are shown by arrows in Figures 8 and 9.

Three other configurations of sensors and sources were deployed and recordings made for each source location. As in the examples just presented there is typically a large variation in signal level and waveform as the source is changed by as little as 1 m, further indicating that the interior of the Osirieon is very heterogeneous and cannot be a solid block of material. A consistent delayed signal is present on many of these recordings with a delay time of approximately 18-19 msec. This delayed signal is interpreted to be a reflection from the base of the Osirieon; if this interpretation is correct the depth to the base of the Osirieon is approximately 15 m, using the measured velocity 1650 m/sec for the solid sandstone surface of the Osirieon.

Conclusions

There are three principal findings from analysis of the seismic data collected at Abydos:

1. There is a prominent trough extending down from the Seti I temple towards the Nile River. There is some evidence that the trough extends into the bedrock.

2. A consistent later arrival observed from deployment of sources and sensors on the Osirieon's surface is likely a reflection from the base of the Osirieon;

the estimated depth of the base is approximately 15 m, if this interpretation is correct.

3. The high degree of variability of signal levels and waveforms as the sources are moved only short distances on the Osirieon surface strongly indicates that the interior of the Osirieon is highly heterogeneous, not a solid block of material. Additional work is needed to determine the characteristics of its interior.

Further detailed analyses of the data collected in this study may reveal other important information concerning Abydos.

Figure 1. General view of the Seti I temple with courts in front and the Osireion in back.

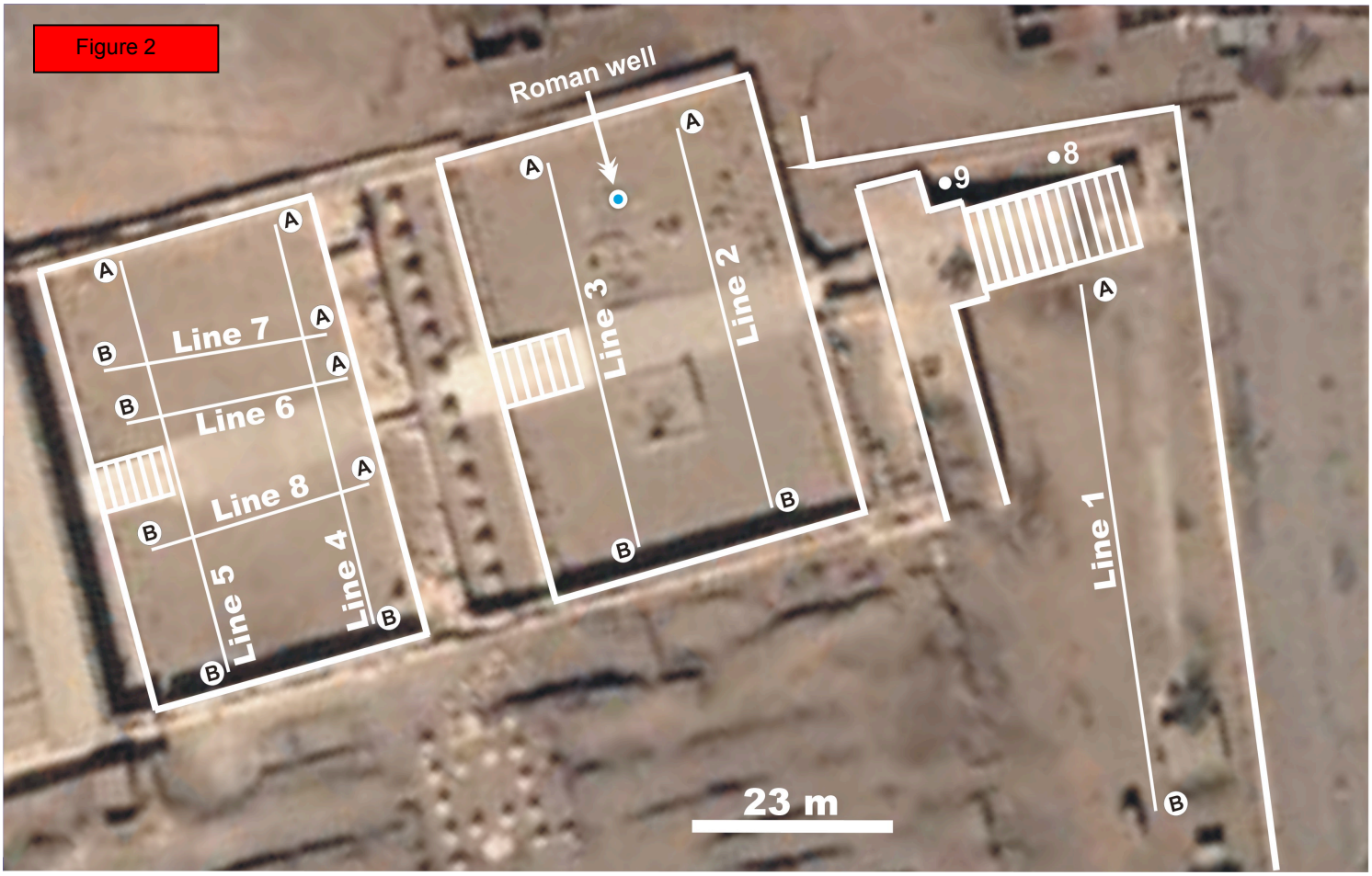

Figure 2. Location of Seismic lines in courtyards of Temple of Sety I, Abydos, Egypt

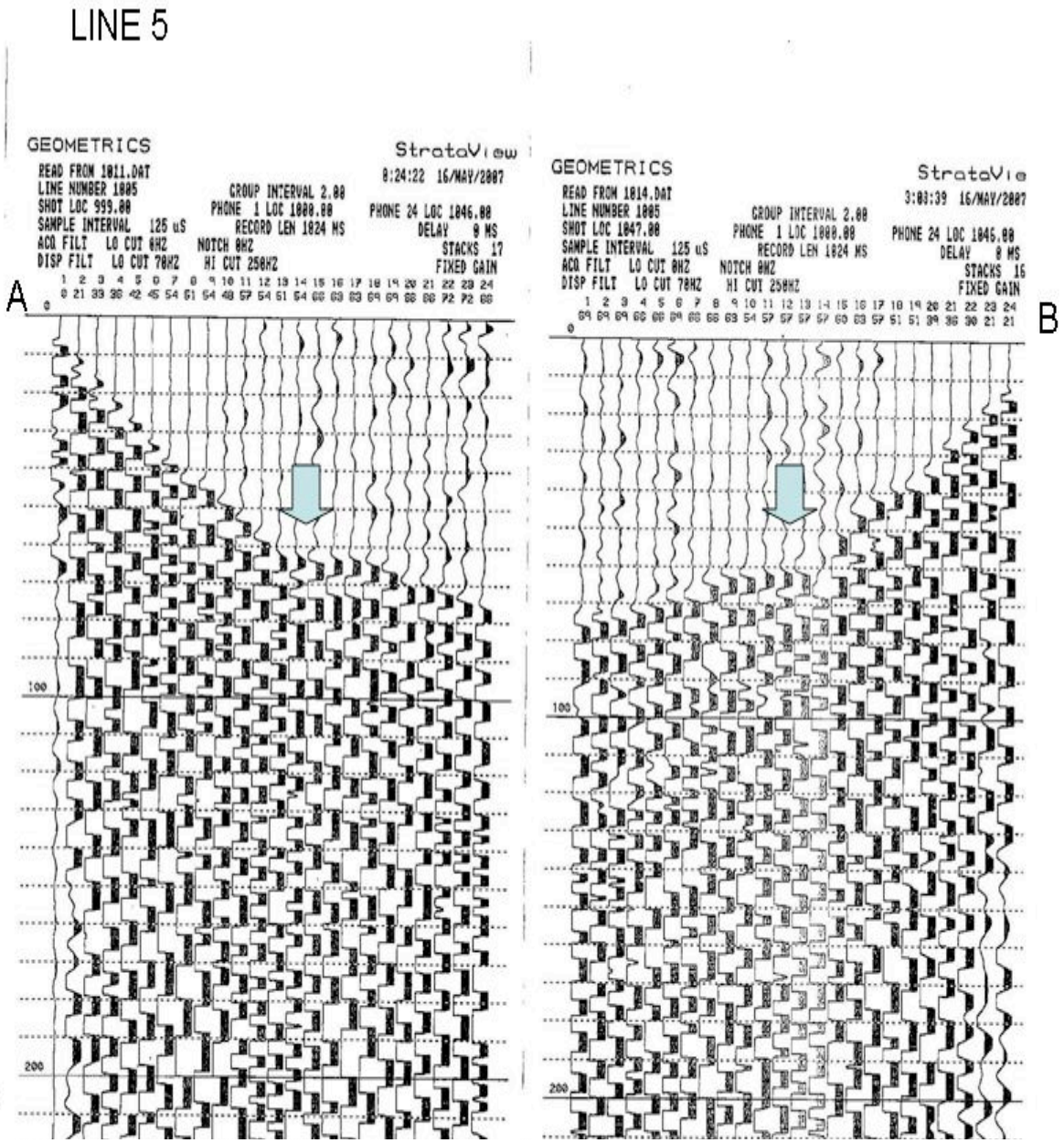

Figure 3. Seismic record sections for Line 5 shown in Figure 2 with a sensor spacing of 2 m. The left section is for the source located at A and the right section is the reverse with the source at B. Time in msec increases downward on the sections. The arrows show the approximate location of a channel.

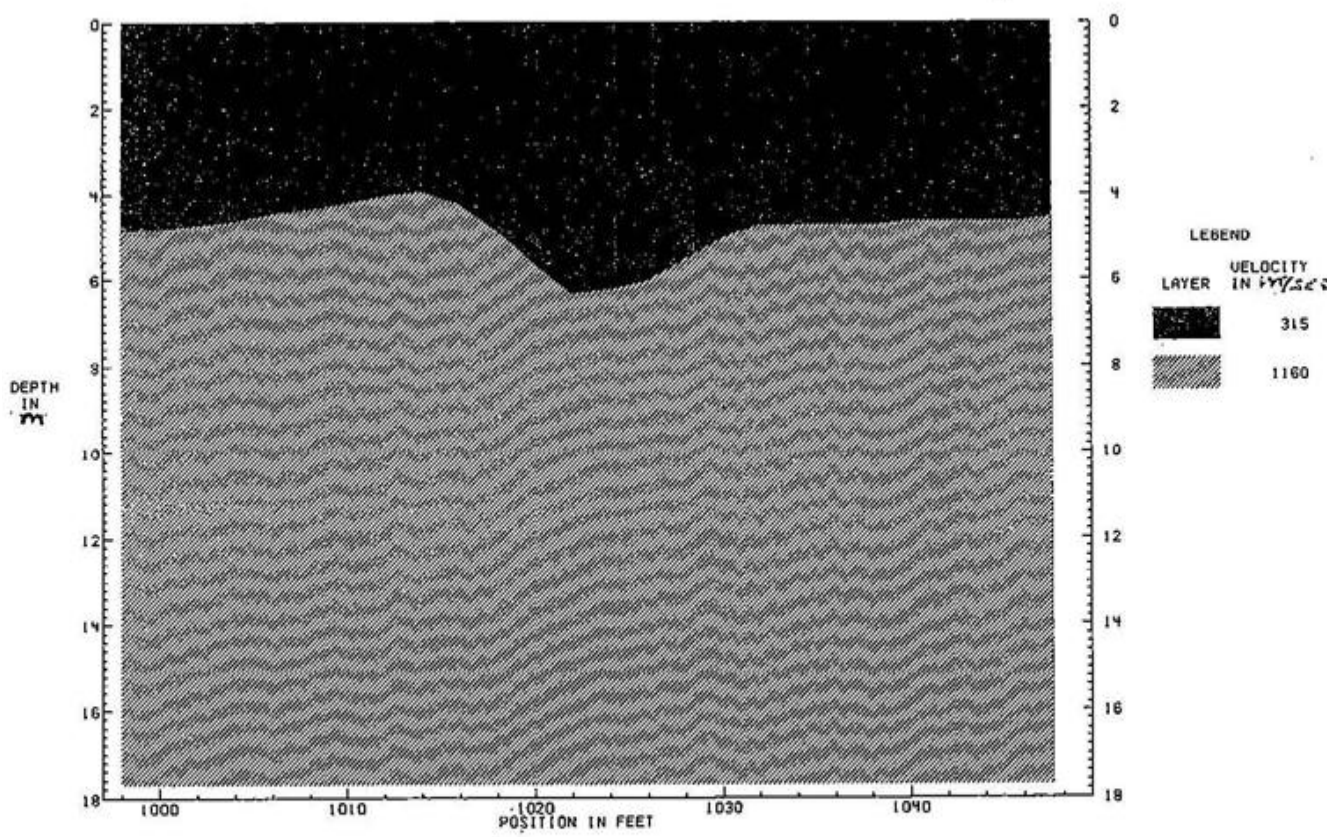

Figure 4. Interpreted cross-section showing a channel in the middle of Line 5 Located approximately at the position of the arrows in Figure 3.

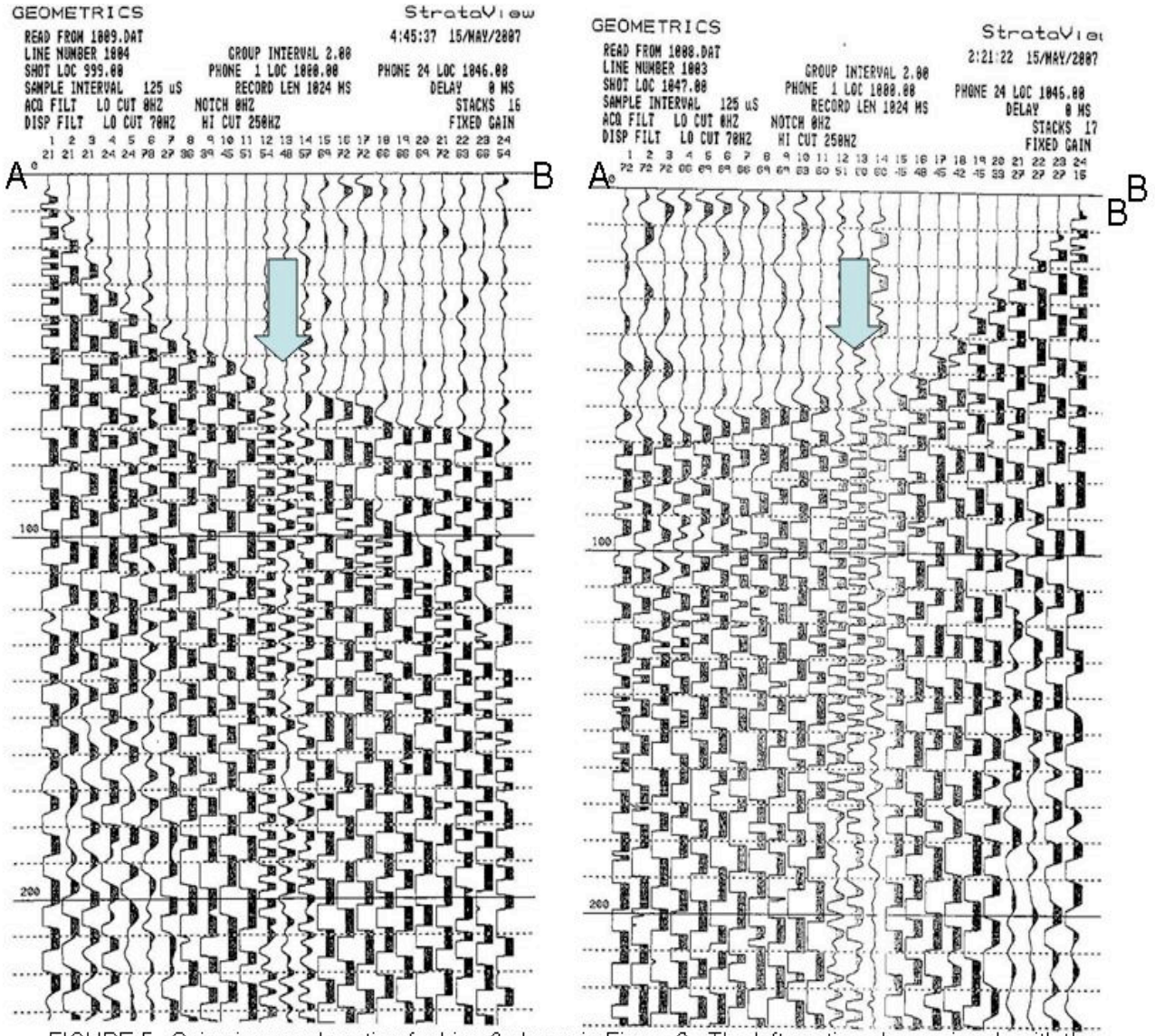

FIGURE 5. Seismic record section for Line 3 shown in Figure 2. The left section shows signals with the source at A and the right section shows the signals with the source at B.

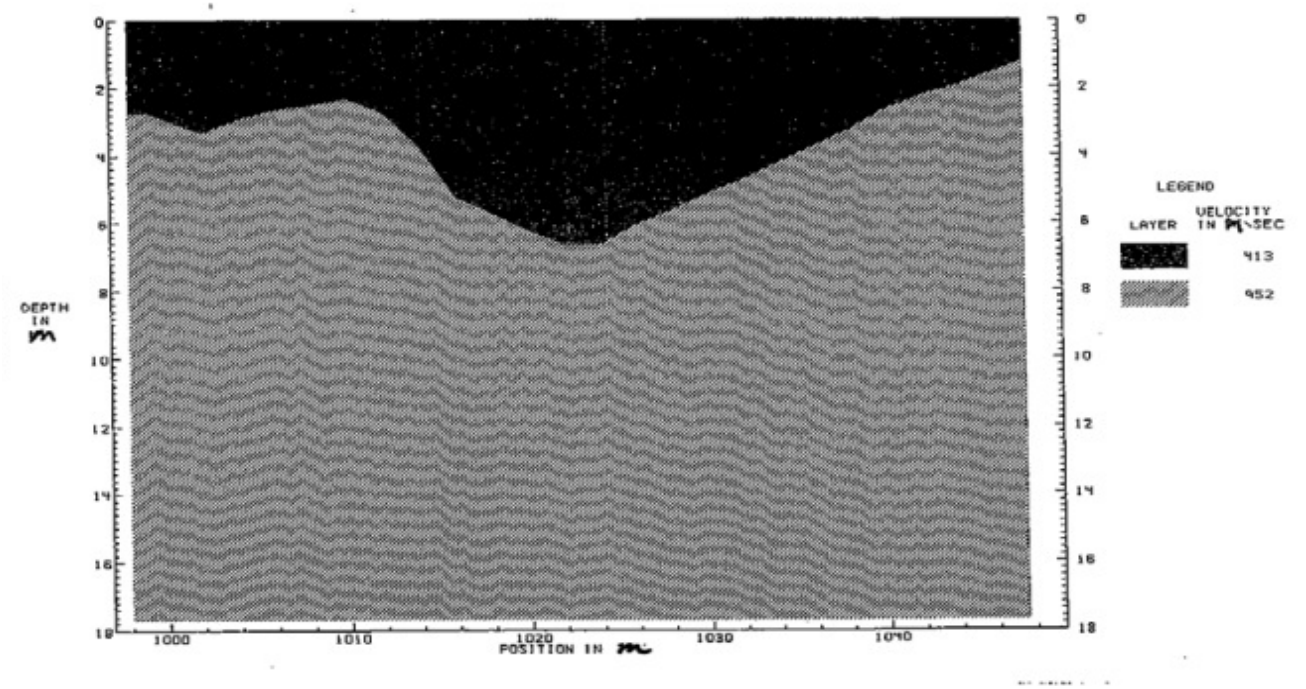

Figure 6. Interpreted cross-section for Line 3 showing a channel in the middle of the profile located approximately at the vertical arrows in Figure 5.

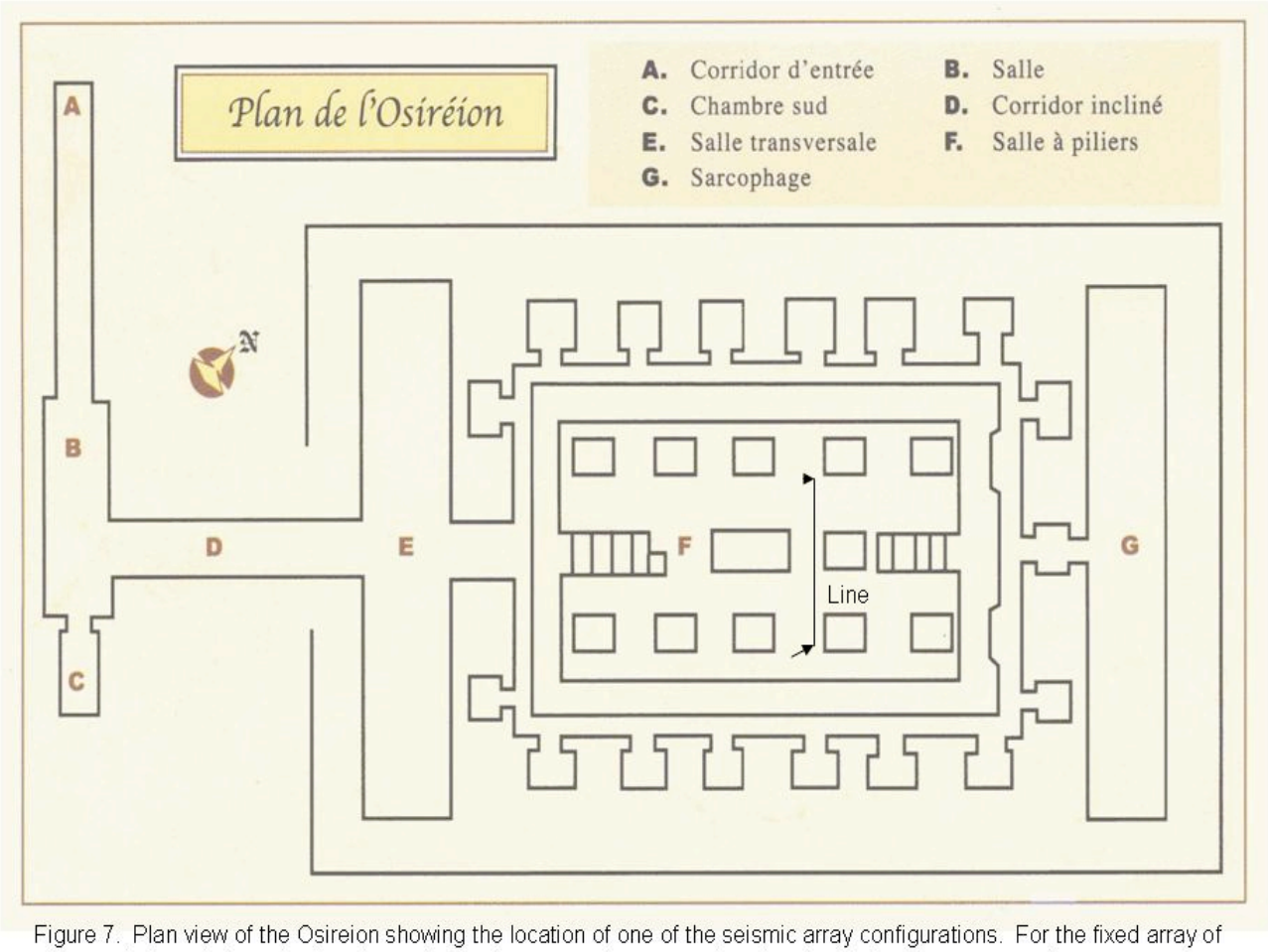

Figure 7. Plan view of the Osireion showing the location of one of the seismic array configurations. For the fixed array of sensors deployed along the line shown (arrows) source points were placed at the end and between each sensor.

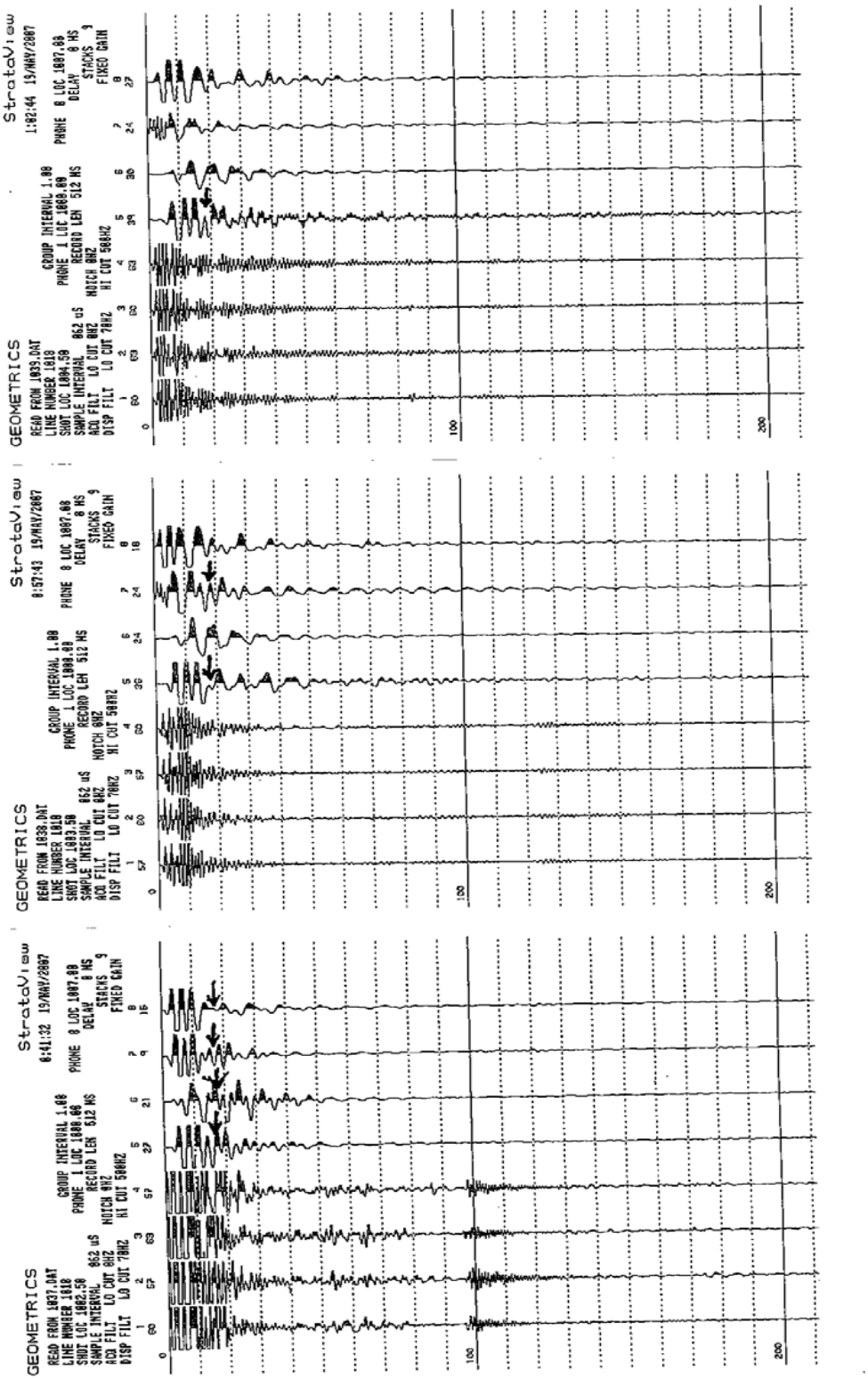

Figure 8. Seismic recordings along the line shown (between arrows) in Figure 7 on the Osirieon top surface for three different source locations along the line. Channels 1-4 are malfunctioning because of water infiltration into the sensors. For the others, as source location is changed by one meter there are very significant changes in signal amplitudes and waveforms. Signals interpreted to be reflections from the base of the Osirieon arrive at the times indicated by the vertical arrows. Time in msec increases to the right for all channels.

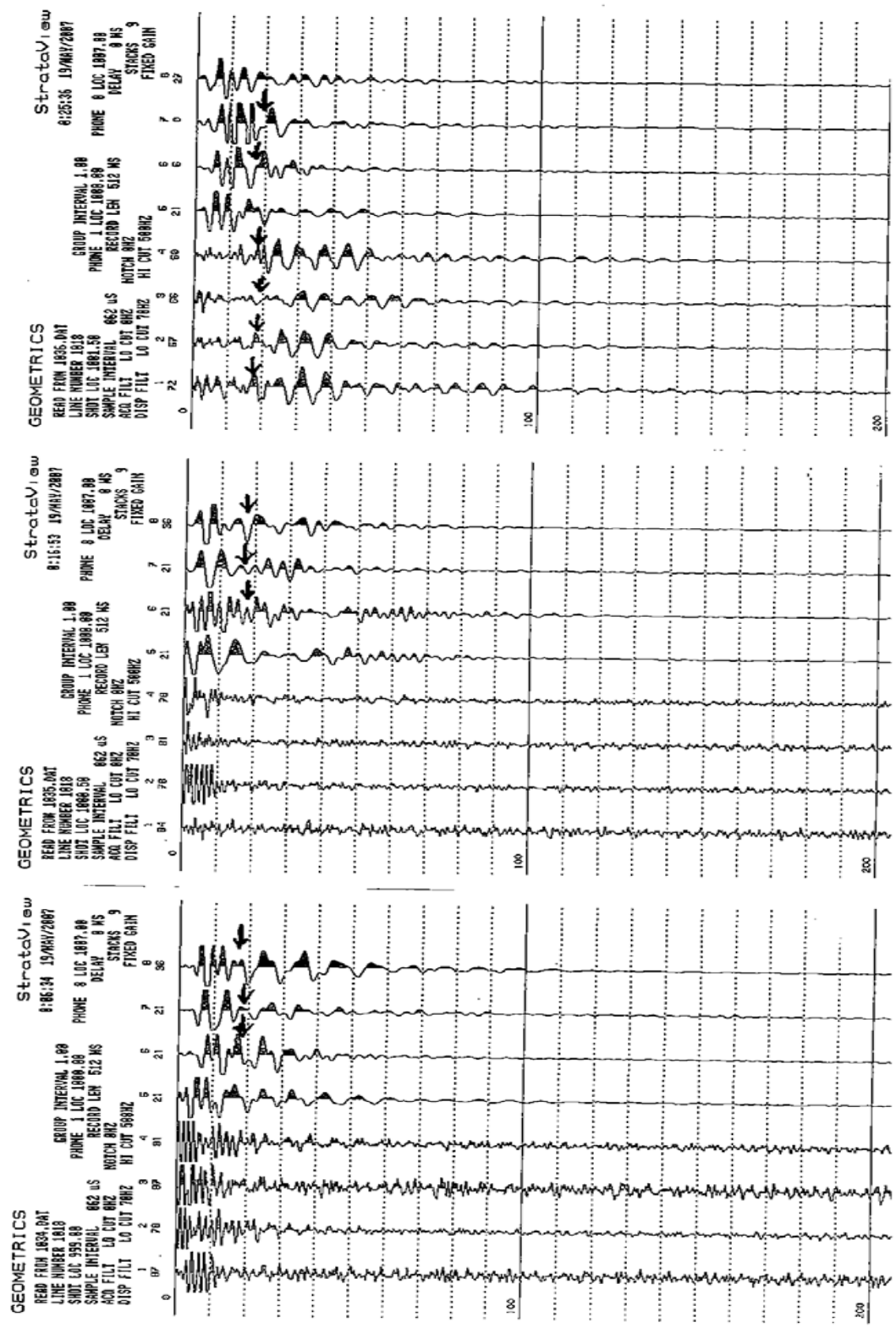

Figure 9. Additional seismic recordings along the line shown in Figure 7 on the Osirieon top surface for 3 different source locations along the line There are significant changes in signal amplitudes and waveforms as the source location is changed by one meter. (Channels 1-4 are malfunctioning for the bottom two sources because of water infiltration into the sensors.) Signals interpreted to be reflections from the base of the Osirieon arrive at the times indicated by the vertical arrows.