ISAP NEWS

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Contents

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Editor's Note

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Welcome to the 23rd issue of ISAP News. I do hope you enjoy reading the articles and are tempted by one of the seminars or conferences on offer. As you go about your work in the coming months please do keep the newsletter in mind and consider contributing to one of the future issues.

Contributions, be it articles course announcements or advertisements, for issue 24 should be emailed to me by 21st July.

Total Field Magnetic, Radar, and Archaeological Studies on the Shores of Yellowstone Lake, Yellowstone National Park, USA

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The Montana-Yellowstone Archaeological Project spent four weeks in 2009 along Yellowstone Lake. Previous reconnaissance demonstrated that the site contained an extensive lithic scatter with substantial potential for intact archaeological deposits. We completed seven grids of magnetic surveys at sites selected after observing the distribution of that scatter. Target sources include fire hearths, pit houses, stone rings, and other such cultural features obscured by deposition and flora. Ice rafted obsidian boulders, on the surface and in the shallow subsurface, contribute significant magnetic anomalies. Mature sagebrush limited our use of ground penetrating radar (GPR) to fractions of two grids.

We acquired total field magnetic intensity (TMI) observations at 10 Hz while walking bidirectional transects one meter apart using a Geometrics G858 Cesium magnetometer. Although the presence of substantial sagebrush in the field areas adds much noise during acquisition, we filter the vast majority of it during subsequent processing.

Figure 1: Field area near Yellowstone Lake. Ten terraces, the oldest greater than 10,000 years, resulting from glacial unloading and Yellowstone caldera magmatism, stand above the current shore.

Successively correcting for diurnal variation of the geomagnetic field, filtering to remove corrugation, and then using matched bandpass filtering to separate the magnetic observations into shallow and deep equivalent layers yields the final magnetic maps (figure 2). Here we use matched filtering to remove longer wavelength components from the fluvial system to better isolate the near surface sources. Typically, to best site potential test units we also calculate the analytic signal of the filtered magnetic grids which helps rank the amplitude of anomalies in our work.

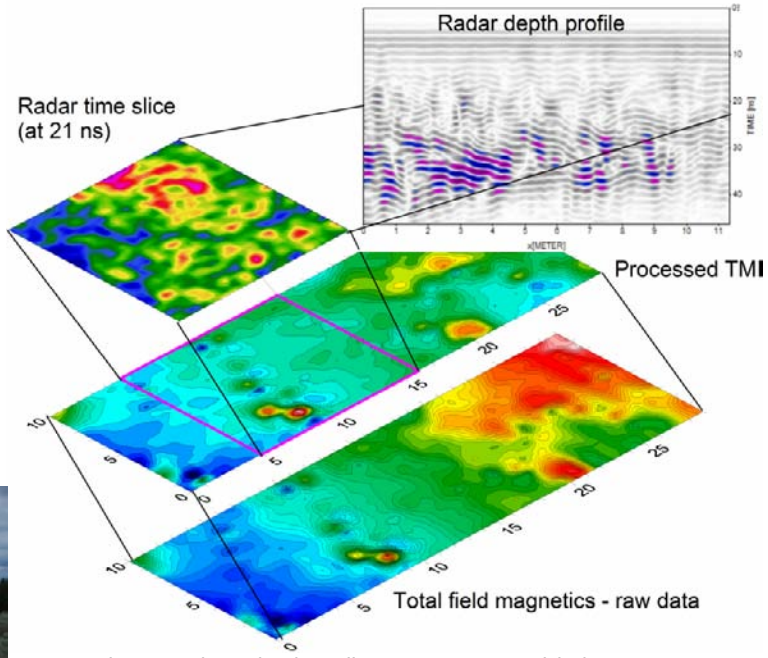

Figure 2: The radar time slice, a 6 nanosecond (ns) average of absolute values from 500 MHz antennas calculated at 21 ns, shows high amplitude arcuate features (warmest colors). Everything below 0.90 meters is fluvial silts and sand as evidenced by GPR interpretation and auguring. The bottom two images compare processed and raw magnetic results (contour interval is 2nT) and show the position of the GPR grid.

A representative GPR time slice (figure 2) shows high amplitude radar features in the northeast corner; they have limited associated magnetic anomalies. Furthermore, the radar features are on the faint extension of an old road that cuts the grid. Inspection of the corresponding depth profiles shows those arcuate features result from

sedimentary structures; auguring confirmed the lack of archaeological features.

On Figure 3, the numbered anomalies (1-6) indicate 1x1 meter test units placed on the combined magnetic and GPR interpretations. The excavation results are:

- TU 1 yielded a fire hearth dating to 1720±40 B.P. (Beta-265305), as well as abundant evidence of obsidian stone tool manufacture
- TUs 2, 3, and 4 yielded only boulders. We excavated these, despite each individual anomaly having the character of a boulder with remanent magnetization, because their concentration and alignment was promising. In a nearby area with similar analysis one such buried boulder turned out to be a long-term bench for flaking and other cultural activities.
- At about 0.8 meters below ground surface, TU 5 contained a fire hearth dating to 2920±40 B.P. (Beta-265306).
- TU 6 contained a rock concentration (likely a hearth) dated at 3,100±40 B.P. (Beta-265307).

Our total field magnetometry and GPR studies combined with archaeological assessment and excavation lead to many interesting discoveries and allowed us to better understand the association of the sources and their anomalies. This feedback will help our 2010 prospection and excavation as the surface conditions for geophysical acquisition are challenging. The area certainly warrants additional investigation as we excavated one test unit that yielded a Late Prehistoric hearth approximately 35 cm above an Early Archaic hearth with a radiocarbon date of 5,910±50 B.P. (Beta-265310). This hearth is the only one in all of Yellowstone National Park to have produced an Early Archaic date. The higher, older terraces have great potential.

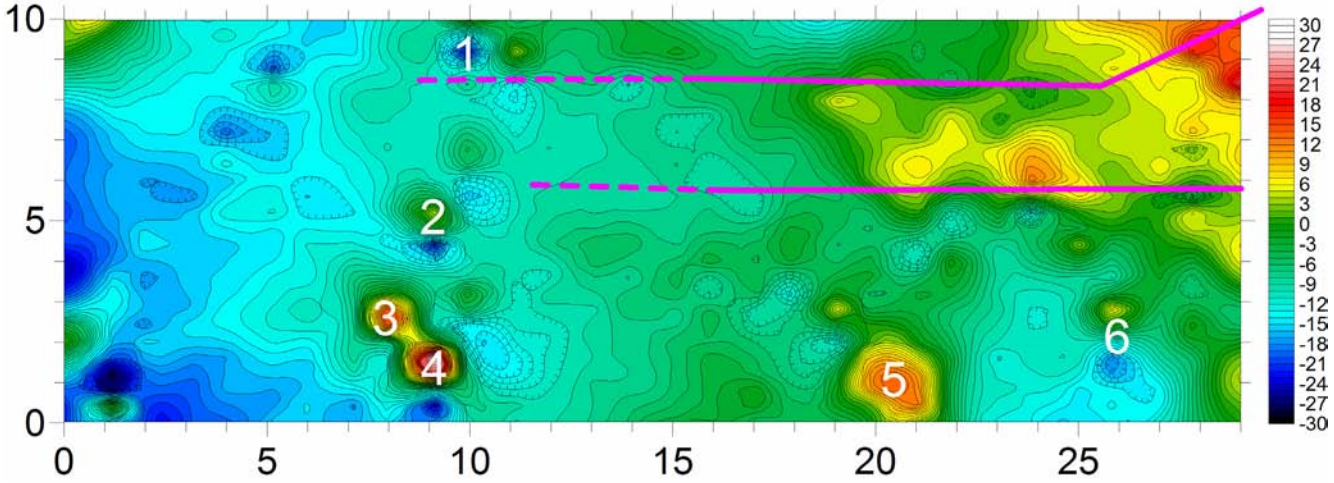

Figure 3: The magenta lines on these processed magnetic results show the interpreted position of a historic road. Numbered anomalies indicate test units; contour interval is 1nT.

An Experimental Proton Precession Magnetometer

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The use of the proton precession magnetometer (PPM) for archaeological survey is attractive both from the point of view of simplicity and potential accuracy and is widely documented. However, making a portable instrument presents some challenges, principally with signal recovery and power consumption. A number of published designs have used frequency counting, but this limits resolution and noise immunity.

This note describes the construction and evaluation of a prototype PPM instrument,