An assessment of EM and potential field data at Pasfield Lake, Saskatchewan-a suspect astrobleme

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Summary

The Athabasca Basin area of northern Saskatchewan provides approximately 20% of the world's uranium production; the majority of this coming from what is termed unconformity style deposits located at the base of the overlying Athabasca sandstone and underlying Archean rocks. Triex Minerals Corporation (now Canterra Minerals) has been conducting exploration in the Pasfield Lake area in the eastern part of the Athabasca Basin since 2005. In the course of this program, a series of aerial and ground geophysical surveys as well as core drilling has been undertaken. This work has to date failed to have revealed the presence of any significant unconformity style uranium mineralization but has shown that there is a major uplift of the basement in Pasfield Lake. The potential field results show concentrically zoned features within the lake and based on the geophysical character of other known astroblemes, there appears to be a reasonable case that Pasfield Lake is located over top of a meteor impact site.

Introduction

Pasfield Lake is located on the eastern side of the Athabasca Basin of northern Saskatchewan, Canada (Figure 1). The majority of the known uranium deposits

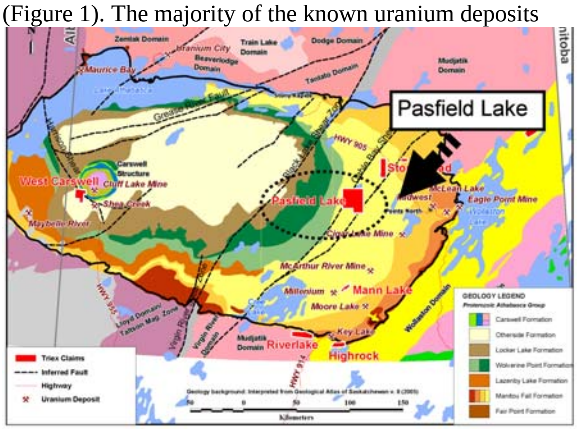

Figure 1: Location of Pasfield Lake, Athabasca Basin, SK.

occur along the eastern side of the Basin but one significant past producer is located on the western side at Cluff Lake. Cluff Lake is a known impact site and uranium mineralization from the unconformity was brought up to the surface as a direct result of the impact event.

The Cable Bay Shear Zone is located on the NW side of Pasfield Lake. Such major structural features are deemed important as pathways for mineralized fluids.

Surveys

2005: The first major survey conducted over the area was in 2005 when a VTEM EM and magnetic survey was carried out. Figure 2 shows the lake, VTEM flight path and drill hole locations. Note, only the southern part of the VTEM survey over Pasfield Lake is shown.

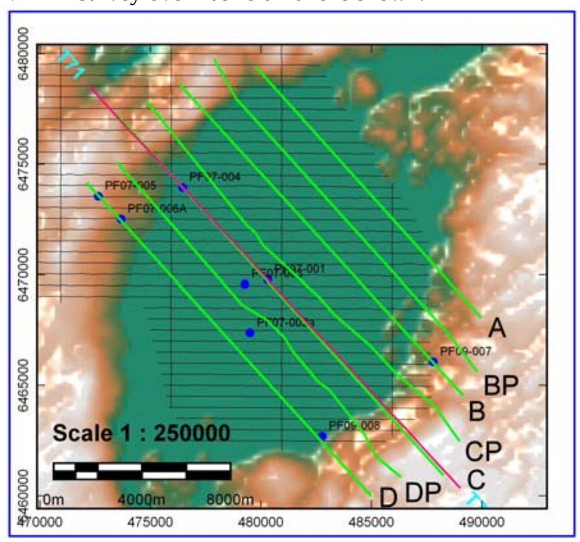

Figure 2: Location of VTEM and TAMT surveys over Pasfield Lake (TAMT lines are shown in green).

Figure 3 shows the TMI and AdTau (time constant) over Pasfield Lake. The magnetic response shows a central circular low and what appears as almost a honeycomb of other lows scattered around in a semi-circular pattern. A strong NE-SW trending high lies along the NW side of the lake. The AdTau response is a roughly circular high centered in the lake.

2007: A Bell Geospace FTG airborne gravity gradiometer survey and a series of Transient AMT (TAMT) lines were conducted over and adjacent to Pasfield Lake. Figure 4 shows the bathymetry for Pasfield Lake and the vertical gravity (Tz) derived from the FTG survey. Water depth exceeds 100 m locally. This information was used to perform the terrain correct on the gravity data and remove to a first order, the effect of water depth on the gravity results. Overall, the lake shows up as a strong circular gravity low. The bathymetry shows a "V" shaped depression in the lake bottom. Not all of this character has been removed from the the Tz result suggesting that these features could be structures with possible low density fault gouge.

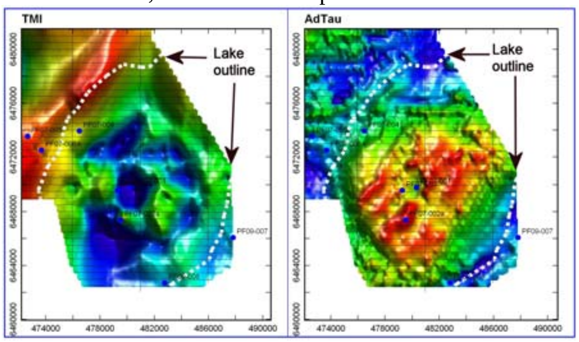

Figure 3: VTEM TMI and AdTau over Pasfield Lake.

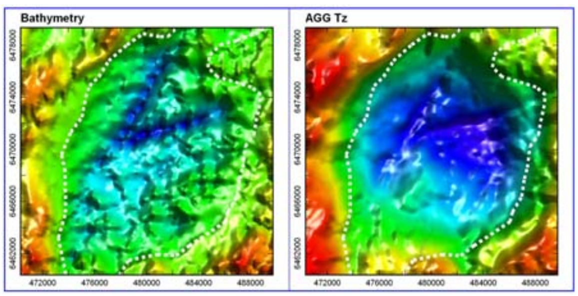

Figure 4: Bathymetry and FTG Tz over Pasfield Lake.

The location of the TAMT survey lines over the lake are shown in Figure 2. Figure 5 shows an example of the processed outcomes for Line B.

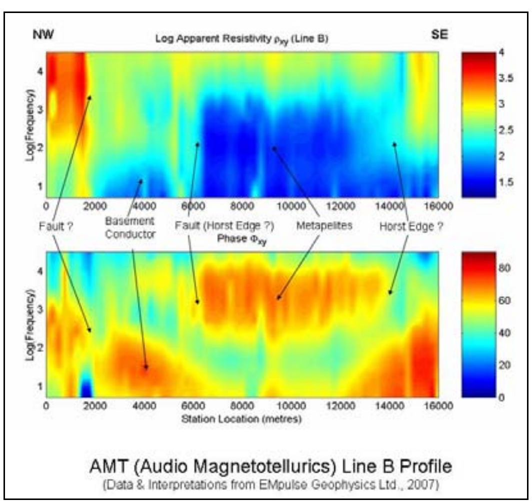

Figure 5: TAMT resistivity and phase results for Line B.

The first round of drilling also took place in 2007 (the diamond drill holes (DDH) are located in Figure 5). DDH were located both in the lake and to the NW and SE on-shore. These results confirmed there to be approximately 600 m of uplift of the basement in the center of the lake with respect to the normal thickness of Athabasca sandstone in this area of ~900 m.

2008: Further TAMT and some detailed FTG surveying was carried out in 2008. In 2008, Tie Line 71 (Figure 2) was flown; this line will serve as the principal section for this assessment.

2009: Two more holes on the SE side of the lake were completed. One hole confirmed a local depth to the unconformity of 906 m; the second hole however, failed to reach basement and was stopped at 1155 m.

Data Processing

During the period 2005-2009, the various data sets were processed and assessed by Triex to support the on-going exploration work. For the present study however, the processing has been largely re-done to facilitate integration and comparison of the results. The major processing work performed is summarized below.

Airborne EM: The VTEM EM data were inverted using a 1D code and then gridded in 3D to create a voxel model.

Airborne Magnetics: Magnetic data acquired concurrently with both the VTEM and Bell FTG surveys and both were modeled using the UBC-GIF code Mag3D, producing very similar results. The modeling was done using no constraint. The Bell survey however, extended over the whole of Pasfield Lake and as a result, is the primary data set for this assessment.

Bell FTG: The provided Tz and Tzz outcomes were processed with the UBC-GIF code Grav3D. The modeling was done using no constraint. A bathymetry survey had been conducted earlier over Pasfield Lake and the details of this survey were provided as part of the Bell outcomes.

TAMT: A full re-processing of the TAMT data, starting from the original recorded time series was undertaken to take advantage of recent enhancements to the Adaptive Polarization Stacking (APS) code. The re-processed data were then inverted in to a 3D model to extract the maximum information content from the data.

Data Assessment

Geology: The primary source of geological information is the drilling undertaken by Triex between 2007-2009. A section running NW-SE through Pasfield Lake is shown in Figure 6. Included are profiles of the gravity and magnetic responses as well as slices through the Mag3D and Grav3D

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models. An uplift of ~600 m is indicated in the drilling between the center of the lake and the SE side.

Airborne: The inversion models for the magnetic and gravity data showed concentric shapes in the center of the lake. Figure 7 shows a 3D perspective image of the magnetic and gravity. A clear central high is apparent in the

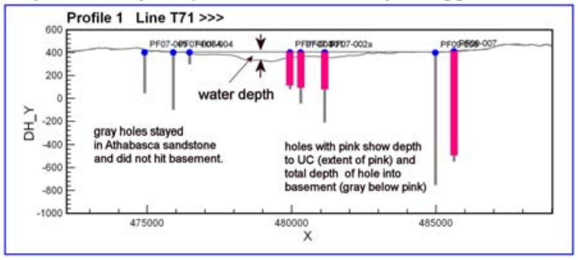

Figure 6: Drilling and geophysical responses through Pasfield Lake (corresponds to Tie Line 71 Figure 2 and TAMT line C (Figure 5).

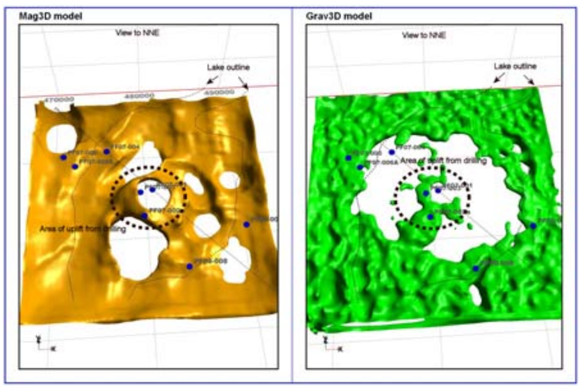

Figure 7: Mag3D and Grav3D models with drilling and Tie Lines 71.

magnetic results. There are a eight apparent holes in the magnetic model. These correspond directly to intense lows visible in the TMI grid in Figure 3. The gravity model shows circular low approximately 18 km across, basically the diameter of Pasfield Lake. Within the low (appearing as a hole in the 3D model) there is some density structure extending from the southern side of the model that goes over the central uplift area, with the gravity showing a roughly circular outline that conforms with the central "hole" in the magnetic model.

Figure 8 shows a section along Tie Line 71 with the gravity and magnetic response in profile form along with slices through the Mag3D and Grav3D models. The uplift in the magnetic model corresponding to the shallower basement from drilling is quite clear. There is a wedge shaped aspect to the bottom of the Grav3D model on both sides. The reality of this is unclear but if so, it suggests the lower density zone extends further way from the center of the uplift in an hourglass like shape. There is one hole going to basement on the southern side of the gravity "wedge". An adjacent hole (but out of the plane of Tie Line 71) did not reach basement.

VTEM: The primary VTEM response over Pasfield Lake was a saucer-like zone of conductivity; this is shown in Figure 9. This response appears to be related to conductive sediments in Pasfield Lake.

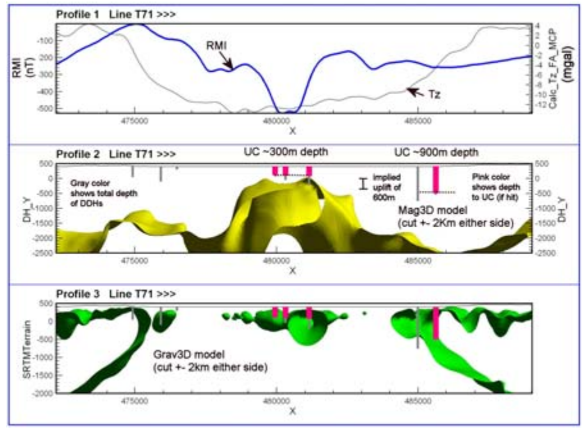

Figure 8: Magnetic and gravity responses in profile form along with cross-sections through the Mag3D and Grav3D models; the drilling results are also displayed.

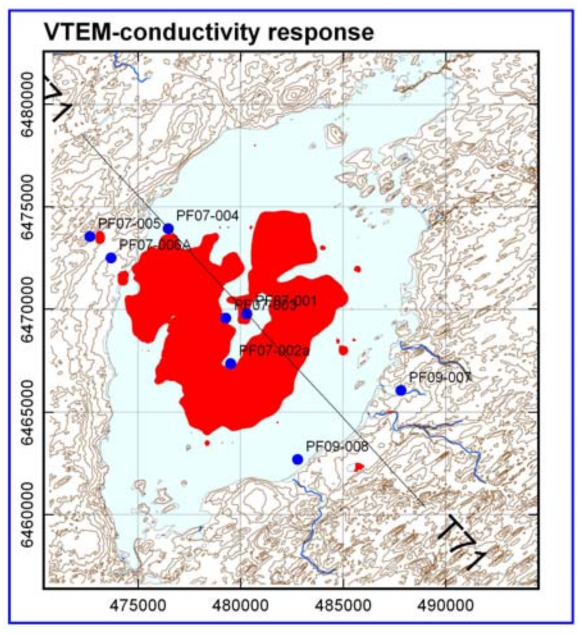

Figure 9: VTEM conductivity response.

TAMT: The re-processing and 3D inversion has enhanced the interpretability of the Pasfield Lake TAMT data set by providing models which are geologically more realistic given the 3D nature of the environment. Figure 10 shows a depth slice at 90 m below surface for the TAMT results superimposed on the Mag3D results. The area shown to be an elevated magnetic response also corresponds to a resistive area in the TAMT outcome.

Figure 11 shows the resistivity section for Line C (Tie Line 71). The zone of defined uplift from the drilling also appears as a zone of perched moderate resistivity on top of a core zone of higher resistivity.

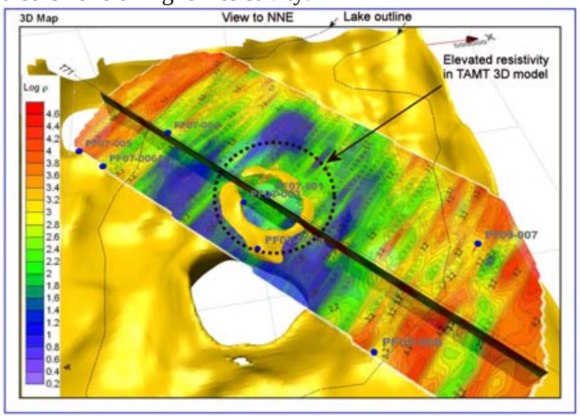

Figure 10: TAMT 90 m depth slice superimposed on Mag3D model (same color scale bar used in Figures 11 and 12).

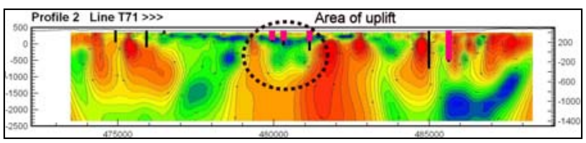

Figure 11: TAMT resistivity model for Line C (Tie Line 71) with drilling and area of uplift highlighted.

Figure 12 shows the TAMT results for Line C compared with sections of the Mag3D and Grav3D models. Zones of strong resistivity low flank the central zone of uplift. These are interpreted to represent zones of fractured (high porosity) rock.

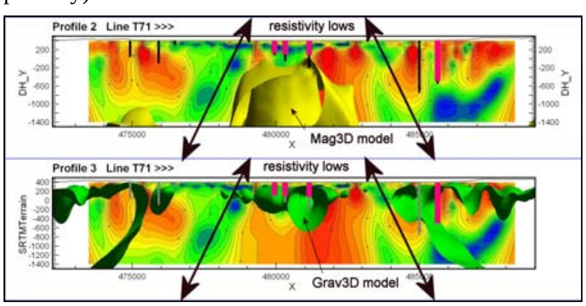

Figure 12: TAMT for Line C and Mag3D and Grav3D models.

Discussion

The primary focus of the surveys discussed has been to assist in the definition of targets which could relate to potential uranium deposits. The classic geophysical model for the Athabasca Basin is a graphite shear zone at the unconformity between the overlying Athabasca sandstone and Archean basement. In the present study over Pasfield Lake, the basement rocks appear to have been brought 600 m closer to surface than is the norm in the area, suggesting a horst-type structure to be present. The origins of this horst are speculative but one possible explanation is deformation of the crust due to a meteor impact. In Pilkington and Grieve 1992, they show that under the certain impact conditions a central high of highly fractured rock can form a dome-like structure in the middle of the impact feature as illustrated in Figure 13.

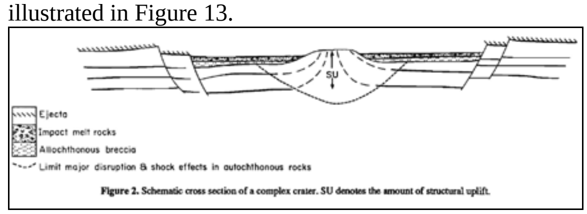

Figure 13: Cross section through crater showing zone of uplift in middle.

In an empirical sense, the models of the potential field results over Pasfield Lake are suggestive of a possible impact feature (Ahern 2003, Goussev et 2003).

The magnetic results at Pasfield appear complex, with numerous intense lows apparent in the area of the suspect impact feature. These lows are interpreted to represent zones of remanence magnetization caused by the melting and then re-solidifying of crustal rocks during the time of impact.

The relative sizes of the magnetic and gravity features at Pasfield Lake also appear to correlate with an assessment in Pilkington and Grieve 1992 regarding the geophysical responses associated with impact features.

As to targets which could represent uranium deposits, the area remains prospective based on the presence of major structural features (Cable Bay Shear Zone) and geochemical evidence. However, no 'normal' basement conductive zones are apparent in the vicinity of Pasfield Lake.

Conclusions

The present study has shown what are regarded as very suggestive but so far unsubstantiated evidence that the Pasfield Lake area was subject to a meteor impact. Hopefully compelling geological evidence such as impact quartz will be recognized at the site that relates specifically to the effects on the crust of high velocity impact by extraterrestrial objects.

Acknowledgments

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EDITED REFERENCES

Note: This reference list is a copy-edited version of the reference list submitted by the author. Reference lists for the 2010 SEG Technical Program Expanded Abstracts have been copy edited so that references provided with the online metadata for each paper will achieve a high degree of linking to cited sources that appear on the Web.

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Triex Minerals Corporation web site, www.triexminerals.com