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Comments on a geophysical survey of the Tufte area

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Memorandum
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W. R. MORAN
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TO: W.R. Moran

FROM: R.B. Ellis RBE

SUBJ: Comments on "A Geophysical Survey of the Tufte Area" by C.W. Carstens

Carstens has done a good job of summarizing his text in the abstract of the report. Consequently, I will direct my comments to each of his five interpretations. In addition, a brief discussion is in order on his approach of using geophysics to evaluate this property as outlined in his recommendations for additional work. I believe his economic considerations are premature at this time and I will therefore only address the geophysics of this property.

1. "Most findings of Nb_2O_5 and P_2O_5 can be correlated from borehole to borehole using magnetic susceptibility and gamma ray (data)".

I have reviewed the drillhole sections (Figures 4-9) which present and in some sections correlate generalized geology, percent magnetite computed from susceptibility, radiometric readings and assay information. In zones indicated to be mineralized with Nb_2O_5 and P_2O_5 there was a recognizable lack of magnetite and correlative radiometric high 62% of the time. A similar result was obtained for the zones indicated to be mineralized with P_2O_5 and Ta_2O_5 separately. Unfortunately, and most important from an exploration standpoint, the observation that a correlation of low magnetite and high radiometric response was not unique to the mineralized areas. This correlation is observed in all rock types indicated. This is particularly visable within the sövite which is characterized by high variability of both magnetite occurrence and radiometric response. Consequently, I feel that any correlation of a mineralized zone in one drillhole to a radiometric/percent magnetite response in another drillhole will be subject to ambiguity. In addition, any statement regarding the continuity of mineralization between intercepts in adjacent drillholes based on geophysical measurements are unfounded because of the lack of any depth information obtained from the techniques of this type.

2. "50% of the drilled mineralizations of Nb_2O_5 can be traced up to surface, revealing magnetic low or high and gamma ray anomalies".

It appears that most of the surface radiometric and ground magnetic responses are a reflection of the variability of magnetite and radiometric mineralogy of the host rocks, particularly the sövite. The only mineralized intercept that intersects the surface and therefore capable of producing a radiometric high is the mineralization near the collar of TH1. This may be causing the narrow radiometric high over the mineralized intercept. All other mineralized zones are too narrow and too deep to be reflected in the surface radiometrics or ground magnetics.

3. "By VLF the resistivity technique (the) rødberg can be (differentiated) from sövite and raudhaugitt. Fault zones and hematite dikes within rødberg are also detectable."

There is a resistivity contrast between the rødberg and the sövite and Raudhaugitt as shown in Figure 11. However, I have some difficulty locating the VLF responses that define the fault zones indicated in Figure 3.

4. "The density contrast between sövite and lamprophyre is 0.3 gm/cm^3. (That contrast indicates possibilities to indicate lamprophyre by gravity techniques)."

There are no data included in the report to substantiate a density contrast of 0.3 gms/cm^3 between the "lamprophyre" and the sövite. If these numbers are correct and the density of the sövite does not vary considerably with the measured variabilities in magnetite content then a gravity survey in restricted areas may be indicated. However, if the magnetite content of the sövite is responsible for its density contrast with the "lamprophyre", then the magnetic survey has already provided the desired result.

5. "The magnetic content of sövite is generally higher than surrounding rock types. (Sövite borders can be inferred from magnetic investigations.)

This statement is well illustrated by the variability of percent magnetite as computed from susceptibility in the drillhole logs.

A brief comment on converting susceptibility measurements made on drill core to percent magnetite may be useful. There is an emperical linear relationship between magnetic susceptibility and percent magnetite with a large amount scatter in the data. This relationship also assumes a uniform magnetite distribution in the rock. Consequently, for geophysical work of this type, the use of susceptibility rather than percent magnetite is adequate and will avoid the possibility of any future misunderstanding about the true magnetite content of the sövite.

Carstens' recommendations for further geophysical evaluation of this property are certainly comprehensive. Information would certainly be gained from completing radon, gravity, dc resistivity and seismic investigations. However, it is unclear to me how all these surveys will increase the probability of locating additional mineralization of the type presently known or perhaps finding a new mode of occurrance.

Seismic investigations are not suited for vertical contact geology which is generally characteristic of carbonatite systems. The acoustic properties of a rock is principally a result of density contrast. Consequently for vertical contact geology, gravity would be a more appropriate indirect mapping tool. If the density contrast of 0.3gms/cm^3 between the mineralized "lamprophyre" and sövite is consistant and not a function of the amount of magnetite in the sövite, additional gravity may be warranted.

The degree to which a radon gas survey allows one to determine the radiometric response of rocks below overburden is a function of various physical characteristics of the soil horizon. These include the amount of water saturation of the soil, groundwater flow, lithology and degree of permeability of overburden. The obvious geologic problem affecting a radon survey is the degree to which the overburden has been transported and therefore in contaminating and/or influencing the response of underlying rocks. This is certainly a major consideration at the Fen. Excluding these variables which are difficult to measure and control, my limited experience of using the "track etch" technique to measure radon gas for uranium exploration has indicated that the technique furnishes a soil difference map. Therefore, I have reservations about the value of such a survey at the Fen. However, if this survey is tried, I suggest it be completed over a limited test area of known subsurface geology prior to a full scale program over the complex.

The VLF survey did show (Figure 11) a conductivity low over the Rödberg and the mined iron ore of Grubeasen. I am uncertain as to the roll that mapping these conductions will play in identifying niobium mineralization. If the known intercept near the collar of TH1 is fracture controlled rather than a segregation, then additional electromagnetics may be warrented. However, I do not see any response in the VLF data that indicated a fracture zone. Additionally, a dc-resistivity survey would be less likely to define such fracture zones if they exist.

As you have probably gathered from my comments, I am somewhat more conservative in my approach to recommend additional geophysics at the Fen than is Carstens. There does seem to be

some merit in considering a gravity survey. However, it is imperative to have a handle on the density contrast between rock types and what physical parameters and/or mineralogy may be influencing this contrast prior to designing such a survey.

RBE/jm
cc: J.W. Keim