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Decorrugation, Edge Detection, and Modelling of Total Field Magnetic Observations from a Historic Town Site, Yellowstone National Park, USA

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ABSTRACT Cinnabar, Montana is a historic town site and railroad depot near the northern edge of Yellowstone National Park and was inhabited between 1883 and 1903. Remains of foundations and old photographs help determine the area of the town, but the south and east limits are unknown. We acquired total field magnetic intensity data to help determine the full extent of the town. Randomly distributed ferrous magnetic sources on the surface and typical noise associated with acquisition complicate the signal. To separate signal and noise we applied filtering and edge detection techniques common in the aeromagnetic industry to our data. Regional removal, decorrugation, upward continuation, and edge detection successfully separated signal and noise. Following filtering, we extracted two larger anomalies from the data set. For those two anomalies, we estimated the edges of their causative sources by calculating the maxima in the horizontal gradient of their anomalies and by inverse modelling those sources; both methods yield similar results. An archaeological test unit excavation within one of the anomalies clearly indicates the remains of buried domestic features, the foundation to a house or other building associated with the late nineteenth to early twentieth century use of Cinnabar. Thus the southeast extent of Cinnabar is greater than previously thought. The lack of surface indicators or adequate historic photography precluded the identification of this buried feature without the aid of the magnetic study. Copyright © 2009 John Wiley & Sons, Ltd.

Key words: Decorrugation; edge detection; filtering; magnetic; archaeology

Introduction

The Montana–Yellowstone Archaeological Project, a joint endeavour of The University of Montana Department of Anthropology and Yellowstone National Park, studies the prehistory and history of the northern portion of Yellowstone National Park (MacDonald, 2007). The historical component of interest entails identifying the former location and extent of Cinnabar (Figure 1), the original Northern Pacific Railroad depot for visitors to Yellowstone National Park between 1883 and 1903. The main area of Cinnabar contains the remains of 11 building foundations, identifiable as depressions upon the current ground surface. Yet a modern layer of up to 10 cm of silty aeolian sand complicates recognition of the vestiges of old structures in much of the area.

Individuals travelling to Yellowstone on the railroad photographed the central areas of Cinnabar during the late nineteenth century. Limited oral history along with two old photographs provides some guidance to the limits of Cinnabar. The historic photographs also helped corroborate archaeological field efforts within specific building foundations, such as the hotel, store, privy, and blacksmith shop. The area southeast of central Cinnabar (Figure 2) lacks building foundations, any adequate photography, or any surface-indication of former buildings. However, the area contains a scatter of historical debris, a possible indicator of buried archaeological deposits associated with Cinnabar.

Our experience, supported by this study and others (e.g. Kvamme, 1998; Larson *et al.*, 1999), is that

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