

Integrated Exploration Platform: software tools for multidata visualization and integrated interpretation

by

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Introduction

Mineral exploration relies heavily on the subjective interpretation of spatially referenced geoscience datasets of increasing variety, resolution, complexity and bias. It has become a challenge for expert geoscientists to extract the most valuable information from such diverse data, in order to integrate all the data into a coherent interpretation. A collaboration project between the Centre for Exploration Targeting (CET) and the Geological Survey of Western Australia (GSWA) aims to address this challenge by developing tools that facilitate the use of spatial datasets in Western Australia. As one of the outcomes of this project, the Integrated Exploration Platform (IEP) was developed to combine human intuition with the computer software to maximize geological knowledge gain, while minimizing visual bias in the interpretation of multiple spatial datasets. The IEP has been developed as a geological information system (GIS) module that facilitates interpretation of multiple spatial datasets through innovative interactive visualization and image-analysis methods. The first publicly available version of the IEP will be launched at the GSWA Open Day 2016 and will be freely available to Western Australian explorers.

The IEP was implemented as an add-in for ESRI ArcGIS, and consists of: (1) visualization tools that assist integrated interpretation of different datasets; and (2) interpretation support tools that improve interpretation confidence through data evidence assessment of interpreted features. Both of these toolsets are built to facilitate user-driven and computer-assisted workflows, with the aim to maximize the benefits of human intuition and computing power, while minimizing the weaknesses from human bias and algorithm inflexibility.

Multidata visualization tools

We introduce interactive blending tools in the IEP that allow datasets from multiple sources to be simultaneously visualized. Blending combines datasets to form a single

display in a way that effectively represents desired information from each dataset. In each of these blending tools the user manipulates a blend cursor that determines the component weighting of each dataset in the blend. The IEP contains a family of different interactive multi-image blending tools (Kovesi et al., 2014), designed to support different types of data critical to mineral exploration, including 2D data such as geophysical data, radiometric data, mineral spectral data, and blending visualization techniques for 3D volumetric data. Additionally, the IEP provides a dynamic range compression (DRC) data enhancement method (Kovesi, 2012) to isolate features of a specific frequency range.

The IEP visualization methods exploit ‘interactivity’ and ‘motion’ for data interrogation. We recognize that static image blends provide limited clarity on the contribution from each dataset. However, user-controlled transition in blending provides better insight into understanding similar versus conflicting information between datasets and how each dataset is contributing to the final blend (example shown in Figure 1). We also apply interactive blending to visualize 3D volumetric data, allowing for novel ways to view features normally obscured within a 3D volume (example shown in Figure 2). Thus, the blending tools in the IEP provide, within a single platform, a variety of ways to comprehend salient features of 2D blends and 3D volumetric data datasets in an effective way.

Interpretation support tools

The IEP provides tools for quantitative feature evidence evaluation, for structural interpretation of geophysical data. By utilizing image-analysis algorithms for contrast-invariant feature detection, namely Phase Symmetry (Kovesi, 1997) and Phase Congruency (Kovesi, 1999), the IEP produces a number of feature-strength maps using a 2D geophysical dataset as input. These feature-strength maps allow the user to identify the locations of ridge-like features, valley-like features, and step edge-like features. These feature-strength maps provide effective feedback on user-interpreted lines (Holden et al., 2016).

The feature-strength maps are visualized by combining the original data through contributions to the colour and brightness components respectively. This allows for an effective way to visualize feature evidence while

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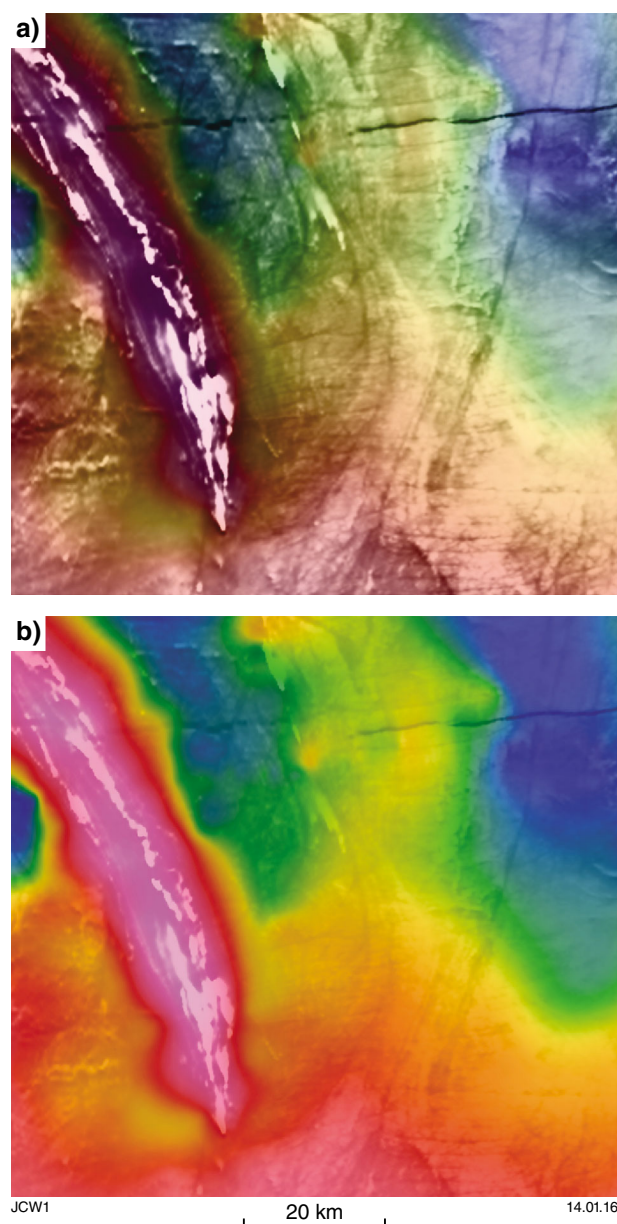


Figure 1. An example of the blend output from one of the 2D blend tools in the IEP. Both images show different blend contributions of two datasets using the Image Wheel blender; ground gravity data is shown with a rainbow, and aeromagnetic data is shown in greyscale.

maintaining the primary contribution from the original data, and is utilized in two modes: as an interactive spotlight region tied to the mouse cursor position (Fig. 3a), and a buffered rectangle along each interpretation line (Fig. 3b). Interactively hovering the mouse cursor over interpretation lines prompts the IEP to display the quantitative values for the line across the ridge, valley, and edge feature-strength maps. This provides an effective overview of how well aligned the interpreted line is to the evidence of each feature type according to the input data.

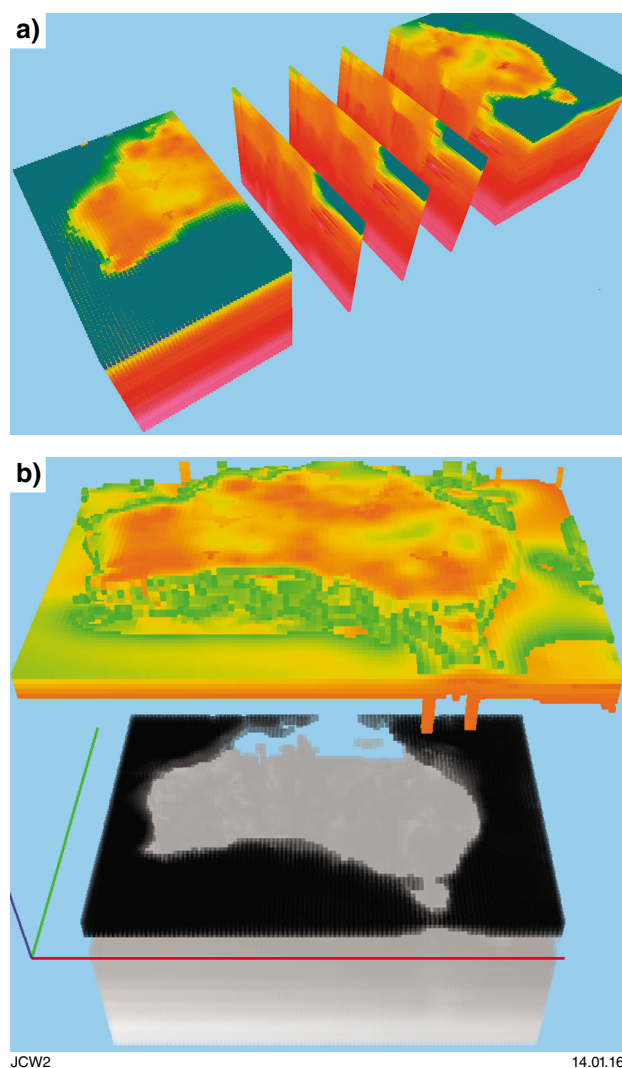


Figure 2. Two examples of 3D visualization tools in the IEP: a) the Book Slice visualization mode: where three adjacent slice 'windows' of data are fixed in position, with interactive adjustments moving the dataset across these slice windows; b) the Threshold Offset visualization mode: an interactively selected range of values determine voxels with values falling within this range to be offset above the volume, and voxels outside this range remain at greyscale, negative representation remaining below. Note that both of these examples use the AuSREM dataset (Kennett and Salmon, 2012).

Both the visualization and the quantitative analysis of the feature evidence provide a framework for feedback so that the user may make informed adjustments and improvements to the interpretation, based on the evidence in the input data.

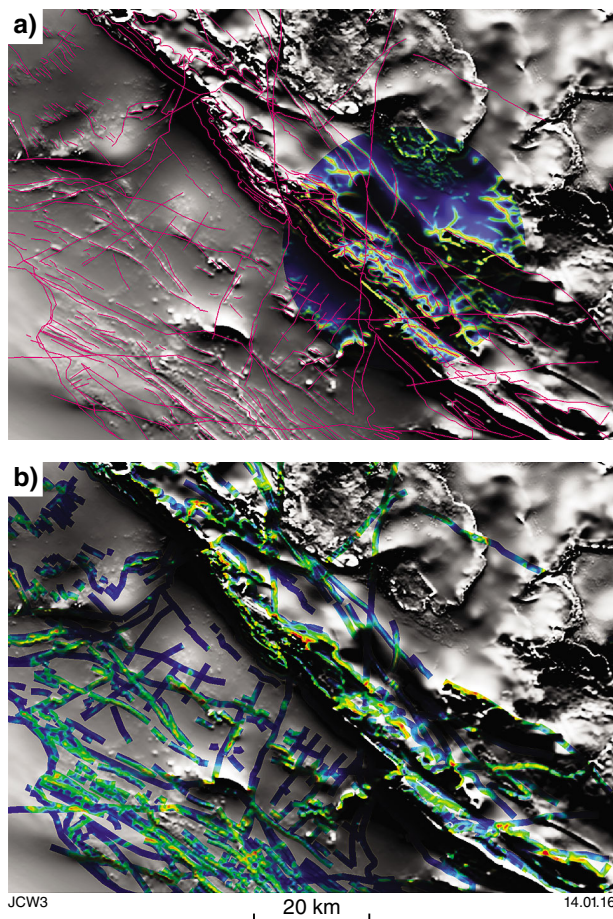


Figure 3. Visualization of feature evidence (in a rainbow map, cool colours indicating weak feature evidence, and warmer colours indicating strong feature evidence) together with the original magnetic data (in greyscale) and the interpretation lines: a) the spotlight visualization mode: a circular spotlight region overlain with the ridge feature map is shown at the location of the mouse cursor and is updated in real time as the user moves the cursor; b) the on-lines visualization mode: the edge feature evidence is shown along each of the interpretation lines, giving an overview of areas well supported by feature evidence.

Conclusion

The IEP has been developed to facilitate more effective data comprehension, and integrated interpretations from multiple datasets. The GSWA Open Day 2016 marks the launch of the official release of the first public version of the platform. Additional features and refinements will be made to the platform to further improve its functionality for mineral exploration workflows.

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