# PRELIMINARY ANALYSIS OF GRAVITY AND MAGNETIC DATA FROM THE ST. FRANCOIS MOUNTAINS, SOUTHEAST MISSOURI

Mark O. Larson, Johnny Bertalott and Kevin L. Mickus

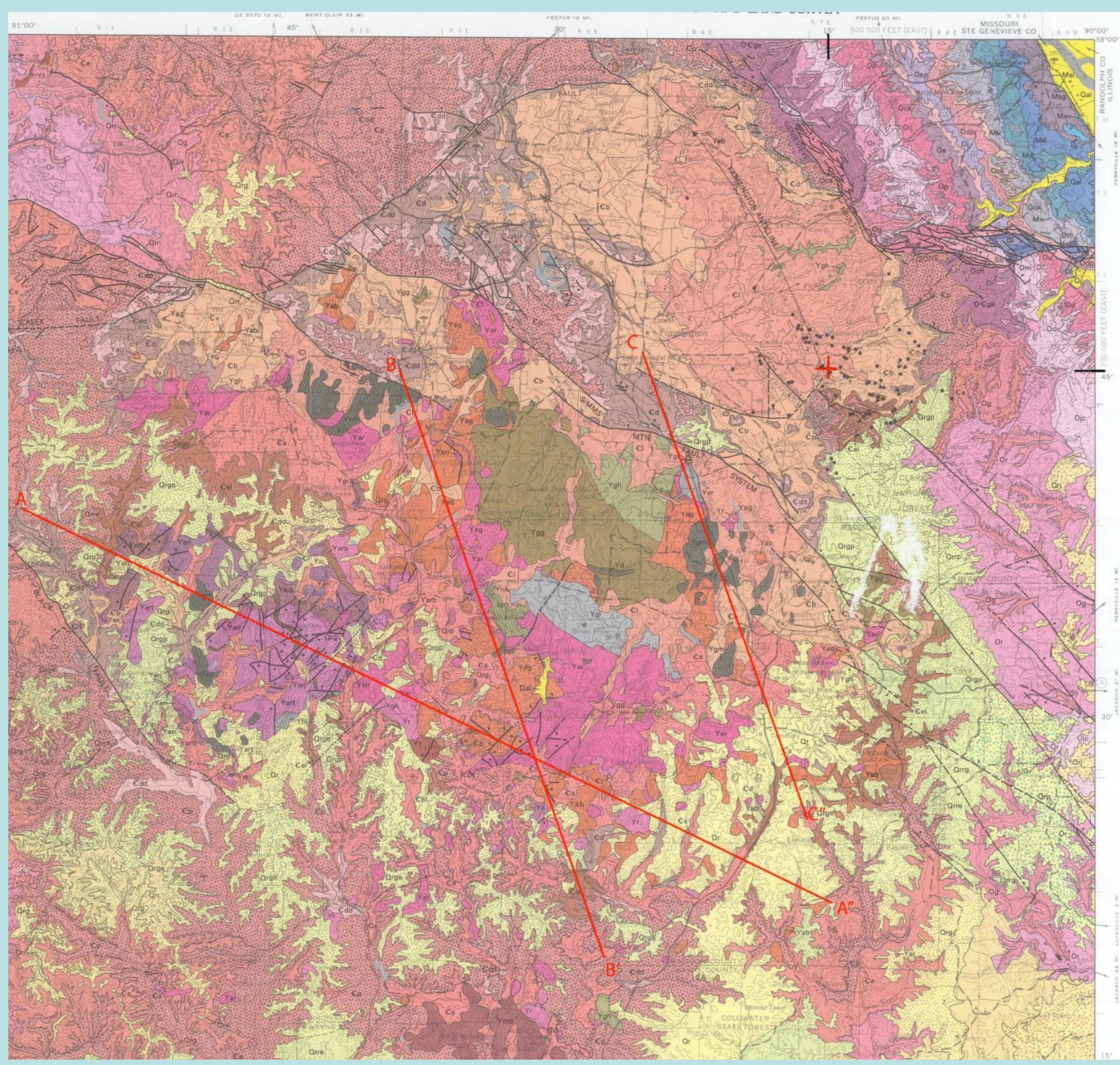
Geosciences, Missouri State Univ., Springfield, MO 65897. mark3@live.missouristate.edu, kevinmickus@missouristate.edu, jbertal@ostatemail.okstate.edu

## Geologic Background

The St. Francois Mountains of SE Missouri are a part of, and the only surficial expression of, the EGR Province.

They are mainly composed of a series of plutons, calderas and ring intrusions which are felsic in nature. And are punctuated by mafic dikes, sills, and dike swarms. Work by Walker et al. (2002) conclude that two major tectonic events controlled two main phases of volcanism. The first being emplacement of the felsics and the first phase of mafics (1.48-1.35Ga). These are believed to be caused by subduction during the Mesoproterozoic. The second phase (1.24Ga) is believed to be due to back arc extension, and is exclusively mafic in nature. Lowel (2000) and Hildebrand (1996) suggest an aulocogenic origin for the second phase. More recent geologic activity related to the Reelfoot Rift and New Madrid Fault zones has created a series of faults that have affected the region. Previous geologic mapping and geophysical studies showed that the area consists mainly of a few large calderas. The calderas are surrounded by ring intrusions, higher in silica content than the plutons they surround. Extensive weathering has exposed these bodies. Rhyolite, tuff, and other pyroclastic units are abundant in the area. Sedimentary units range from absent too prevalent in the region. Our research focuses on determining the upper crustal structure of the region. We aim to determine the location of mafic bodies, the geometry of the ring intrusions, and the depth and geometry of sedimentary units.

## Geologic Map



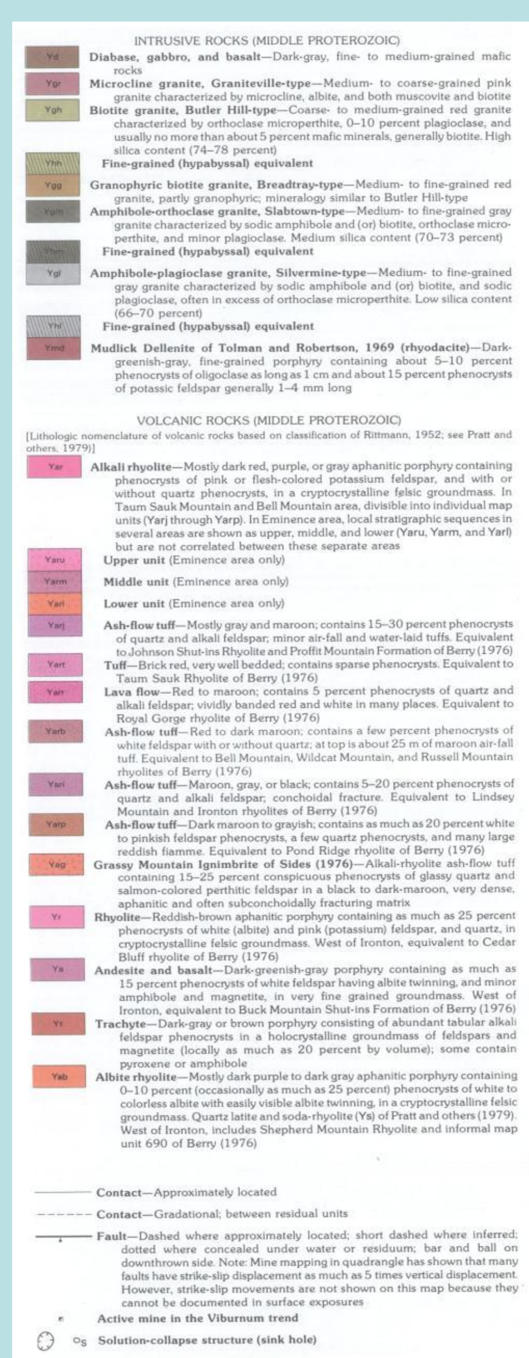


Fig. 1: Geological map of the St. Franciois Mtns. region (Pratt, 1992). Precambrian granitic rocks dominate the region. (Only igneous rocks shown in the legend.)

## Bouguer Gravity Anomaly Map

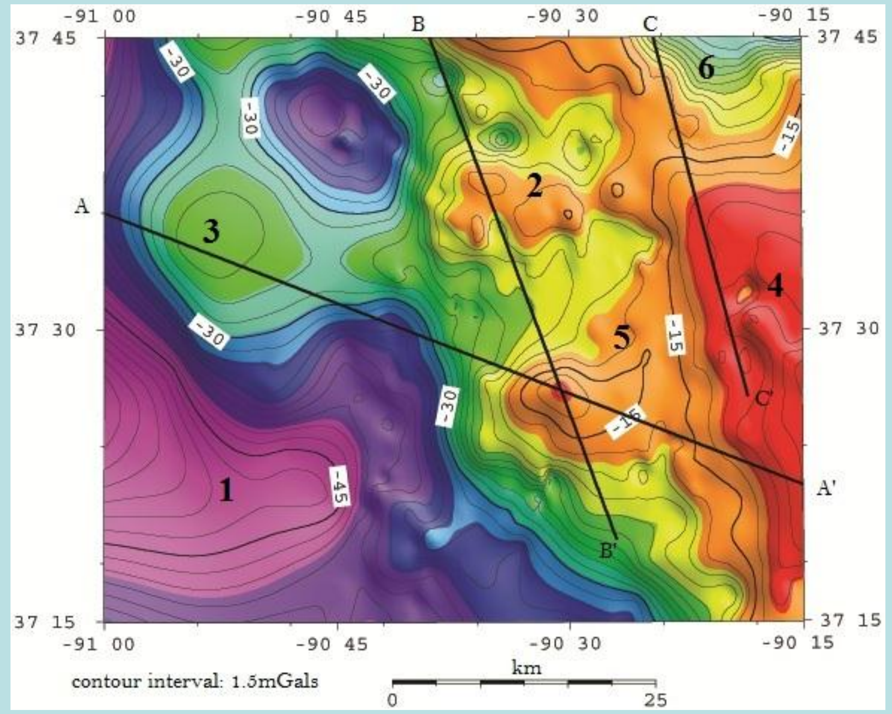


Fig. 2: New gravity data were merged with previous data to create a Bouguer gravity anomaly map. Prominent anomalies are 1-Missouri Gravity Low, 2-Butler Hill Caldera 3-Taum Sauk Caldera, 4-Lake Killarney Caldera, 5-Magnetite rich Lithologies. 6-Hawn Park Caldera (SW edge) A-A', B-B', C-C' are the locations of gravity models.

## Residual Gravity Anomalies

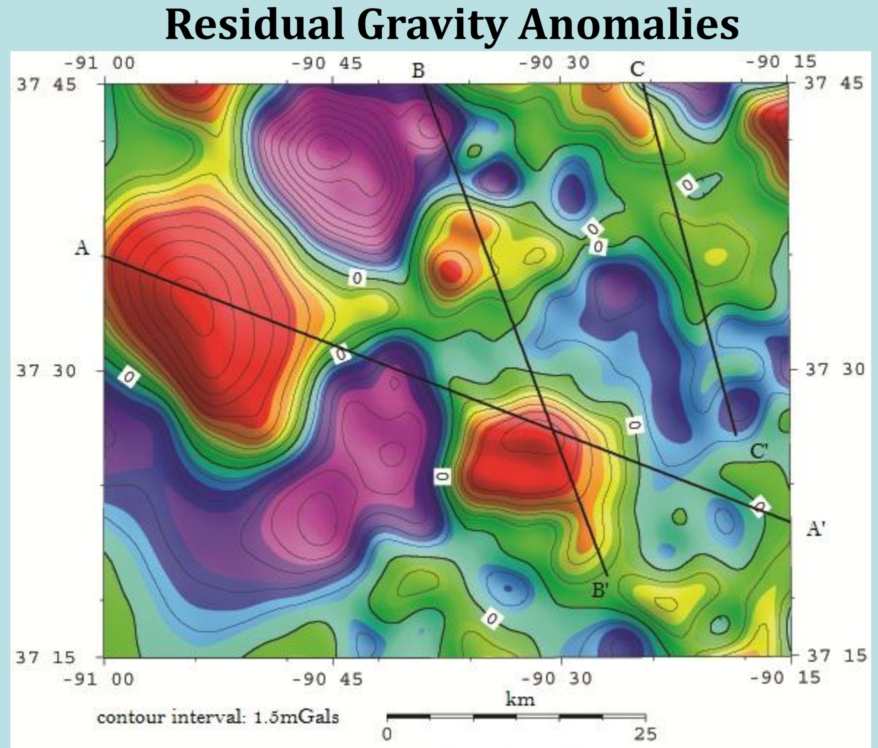


Fig. 3: A bandpass (5-50 km) filter was applied to the Bouguer gravity data to attain a residual gravity anomaly map. The calderas seen in the Bouguer gravity map are highlighted here. Of question is the Taum Sauk caldera. There is a large known dike beneath. We are still determining the source of these features.

## Magnetic Anomaly Map

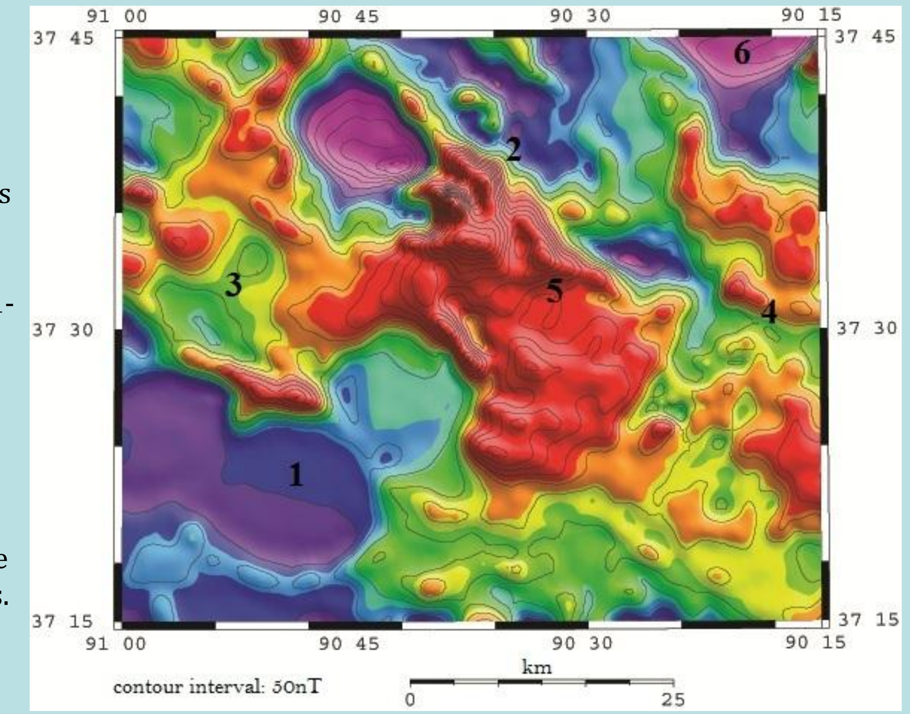


Fig 4: A residual magnetic anomaly map showing the locations of the same anomalies (numbered) seen in the Bouguer gravity anomaly map. The magnetic maximum in the center of the map is believed to be due to mafic material (dikes, dike swarms, sills) and high levels of magnetite in the upper crust.

## Residual Magnetic Anomaly Maps

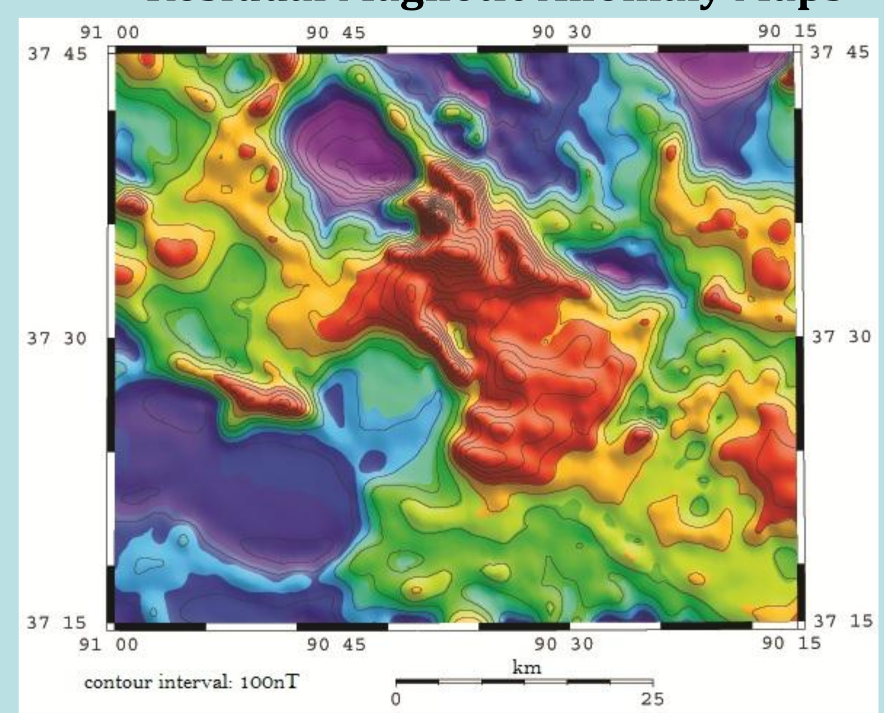


Fig 5: A band pass (1-20 km) filter was applied to the magnetic data to attain a residual magnetic anomaly map. Many of the anomalies from the gravity maps agree with the filtered magnetics. We are still determining the source of these features to the magnetic data. The caldera boundaries have become delineated with filtering as well. We are still determining the cause of the magnetic low where we had seen the highest gravity anomaly. Of note is the punctuated magnetic anomalies that remain. There is a circular structure.

## 2.5-D Gravity Models

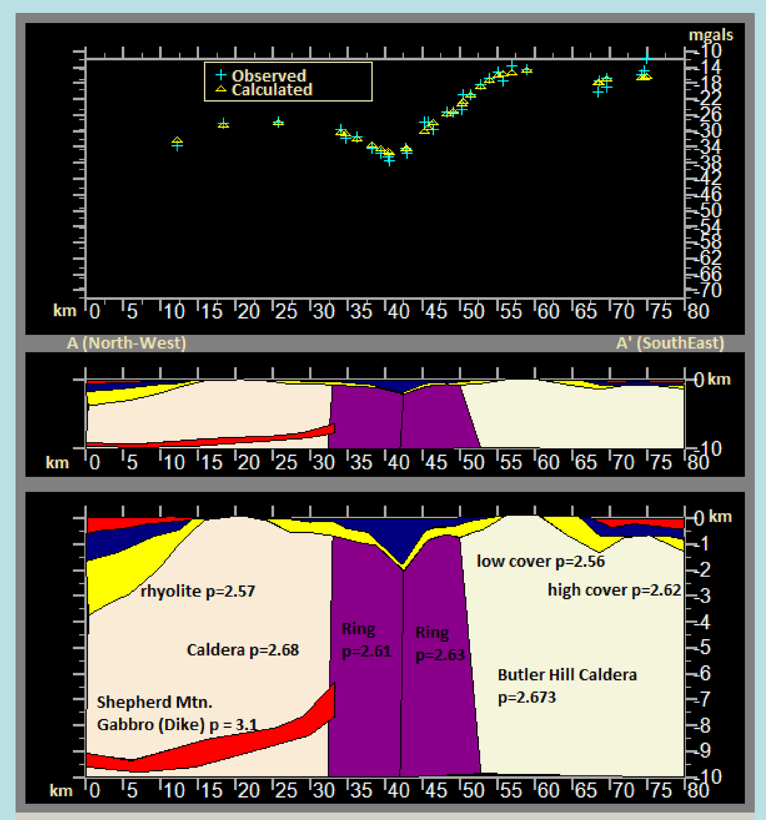


Fig 6.1: Profile A-A' cuts across 3 significant anomalies, 2 gravity maxima and 1 minima (Densities in g/cc)

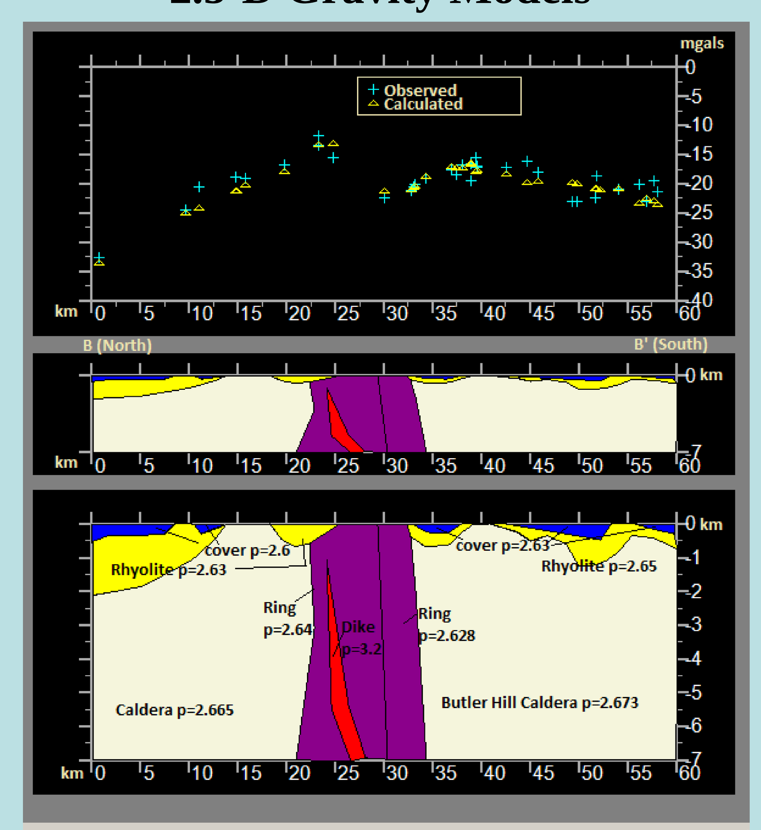


Fig. 6.2: Profile B-B' highlights a series of smaller amplitude anomalies. (Densities in g/cc)

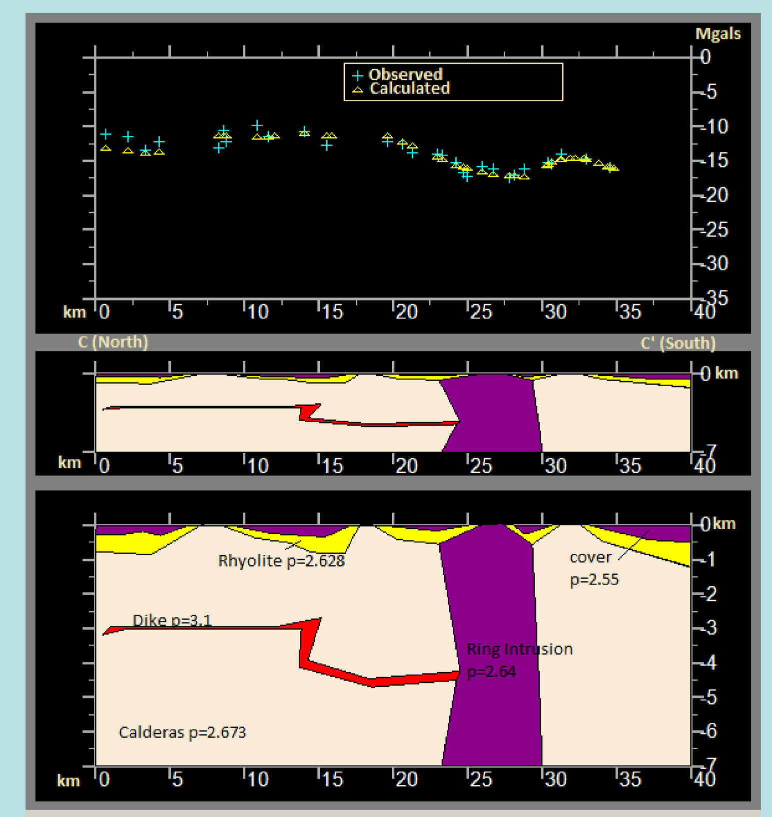


Fig. 6.3: Profile C-C' shows low amplitude anomalies. There is significant mafic dikes outcrop along this surface. (Densities in g/cc)

Two-dimensional gravity models showing one possible upper crustal density configuration of the St. Francois region. These models represent a first attempt at determining the density distribution and will be modified later. We are still collecting data to determine if the density value is the same along our three profiles. In Figs. 6.1 & 6.2 there the Shepherd Mtn Gabbro has been found from core samples. This anomaly in the lower crust accounts for such a low. Our model can be complicated with more dikes, we are awaiting access to core from the Missouri Geological Survey.

Previous petrologic investigations have determined a density value of 2.67g/cc for the granites of the St. Francois region (Hildenbrand, 1993). I took measurements from samples collected by Dr. Thomas Plymate (MSU) and found densities reflecting those used in the models. Variability was higher than expected. The Elsey group of dolomites/sedimentary rocks have been determined to have a density of 2.7g/cc (Hildenbrand, 1993). We tried to account for this in our profiles. We used varying densities for our sedimentary cover rocks as determined by geologic maps. We are still determining the exact value of sedimentary density and geometry and position of specific units

## Methods

We conducted a preliminary gravity survey which we collected gravity data in order to fill in gaps where the available data was sparse. All the data were merged and a Bouguer gravity anomaly map was created and showed anomalies that agreed with the location of the proposed calderas determined from previous studies. (Figures 2 & 6a)

Then detailed gravity data were collected along two profiles (1 mile spacing) that cut across these anomalies. We used 2.5-D forward modeling on the two profiles, which will be constrained by surface density measurements and surface geologic features, to determine the geometry and thickness of the calderas and the upper crust. Additionally, we constructed a series of residual and horizontal derivative gravity and magnetic anomaly maps will be created in order to better constrain the 2.5-D models.

We digitized a geologic map (Pratt, 1985) and superimposed the igneous rock outcrops to better understand our Bouguer gravity maps and models (Figures 7a & 6).

A Lacoste & Romberg Gravimeter and Topcon D-GPS unit were used.

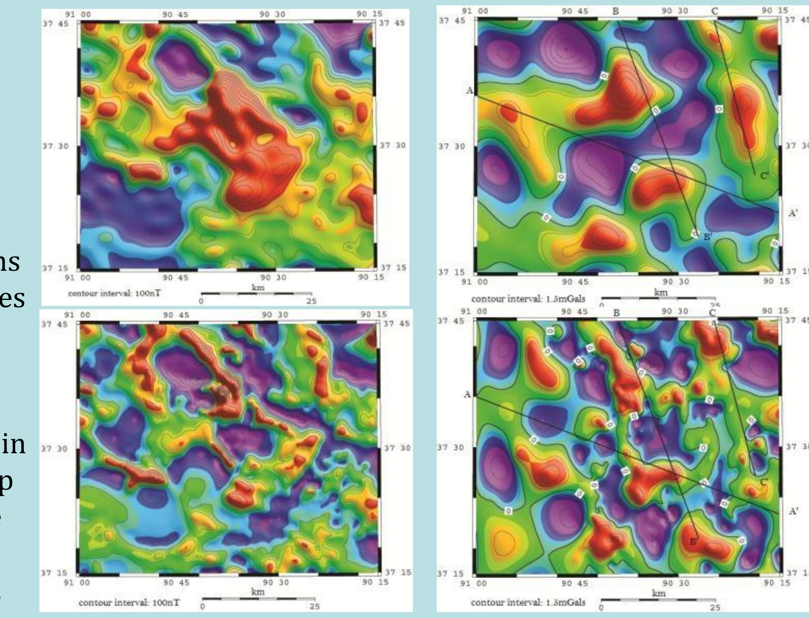
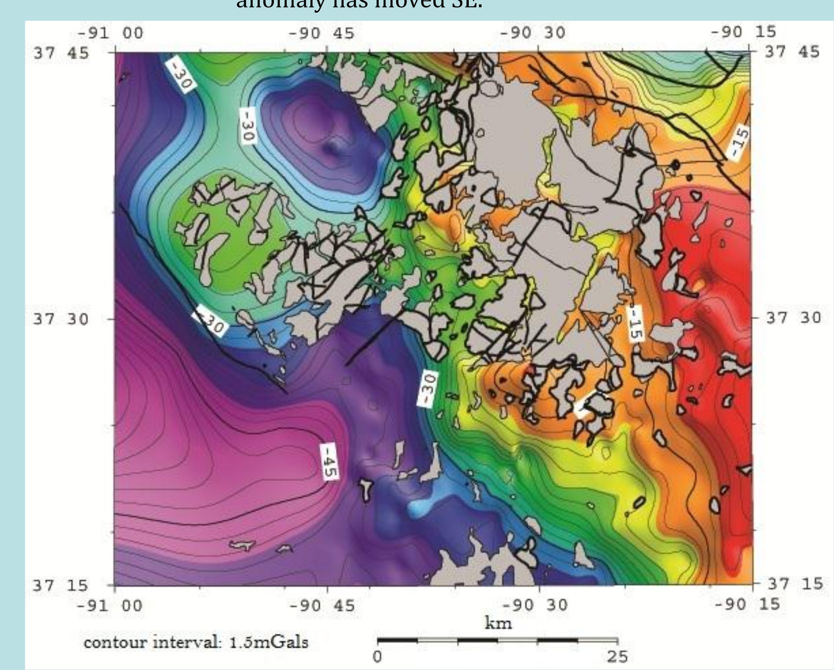


Fig. 8a ,b,c,d: 8a (top left) Bandpass filtered (5-50km) magnetic anomaly map. Showing roughly the same things found with a smaller filter. 8b (top right) shows a Bandpass (30-5km) filtered residual gravity map. Of note is the large decrease in the Taum Sauk Caldera, and large increases near the Missouri Gravity Low and the Lake Killarney Caldera. 8c (bottom right) is bp (15-1km) magnetic map. The circular features are more punctuated. The large anomaly is nearly absent. 8d (bottom left) is bp (20-1km) gravity. Anomolies become more prevalent. And the Taum Sauk anomaly has moved SE.



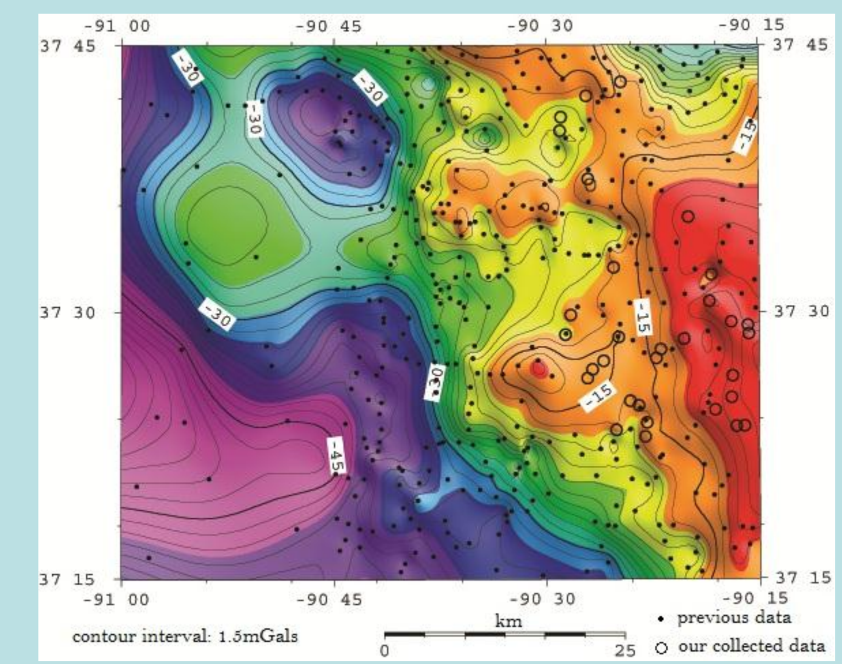


Figure 7a(left) and b(right): Fig. 7a is the location of igneous outcrops (grey) and exposed faults (thick black lines). The outcrops dominate the Butler Hill caldera and also where the magnetic high occurs. These areas have dikes swarms and dikes. We are considering including the faults in profiles. Fig. 7b shows the location of gravity stations.

## Acknowledgements

I would like to thank Johnny Bertalott for getting us started on the project. Dr. Kevin Mickus for willingness to advise us on our independent project and for trusting us with his equipment for days at a time. I would like to thank Dr. Thomas G. Plymate for his input on the geometry of the 2-D models, and for access to his personal collection of ~ 100 samples from the region. And Danielle Smith for putting up with my long nights spent on the project.

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