

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 37 30 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.



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.)

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

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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 ocations of gravity models.





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 ighlighted here. Of question is the Taum Sauk caldera. There is a large known dike beneath. We are still determining the source of these features.

granite, Butler Hill-type-Coarse- to medium-grained red gran

- e, partly granophyric; mineralogy similar to Butler Hill-type rthoclase granite. Slabtown-type—Medium- to fine-grai
- phibole-plagioclase granite, Silvermine-type—Medium- to fine-grained 56-70 percent) ine-grained (hypabyssal) equivalent Iudlick Dellenite of Tolman and Robertson, 1969 (rhyodacite)-Dark-
- eenish-gray, fine-grained porphyry containing about 5-10 percent of potassic feldspar generally 1-4 mm long VOLCANIC ROCKS (MIDDLE PROTEROZOIC) are of volcanic rocks based on classification of Rittmann, 1952; see Pratt and
- Alkali rhvolite-Mostly dark red, purple, or gray aphanitic porphyry containing nenocrysts of pink or flesh-colored potassium feldspar, and with or without quartz phenocrysts, in a cryptocrystalline felsic groundmass. In aum Sauk Mountain and Bell Mountain area, divisible into individual ma units (Yarj through Yarp). In Eminence area, local stratigraphic sequences several areas are shown as upper, middle, and lower (Yaru, Yarm, and Yarl)
- but are not correlated between these separate areas per unit (Eminence area only) Middle unit (Eminence area only)
- Lower unit (Eminence area only) Ash-flow tuff—Mostly gray and maroon; contains 15–30 percent phenocryst guartz and alkali feldspar, minor air-fall and water-laid tuffs. Equivalent ion Shut-ins Rhvolite and Proffit Mountain Formation of Berry (197
- Iff—Brick red, very well bedded; contains sparse phenocrysts. Equivalent t aum Sauk Rhyolite of Berry (1976) ava flow-Red to maroon: contains 5 percent phenocrysts of quartz and kali feldspar; vividly banded red and white in many places. Equivalent to yal Gorge rhyolite of Berry (1976) sh-flow tuff-Red to dark maroon; contains a few percent phenocrysts of
- e feldspar with or without quartz; at top is about 25 m of maroon air-fa Equivalent to Bell Mountain, Wildcat Mountain, and Russell Mountai olites of Berry (1976 Ash-flow tuff—Maroon, gray, or black; contains 5-20 percent phenocrysts o uartz and alkali feldspar, conchoidal fracture. Equivalent to L
- ntain and Ironton rhyolites of Berry (1976) sh-flow tuff—Dark maroon to gravish: contains as much as 20 kish feldspar phenocrysts, a few quartz phenocrysts, and many large eddish fiamme. Equivalent to Pond Ridge rhyolite of Berry (1976) Grassy Mountain Ignimbrite of Sides (1976)-Alkali-rhyolite ash-flow tu ontaining 15–25 percent conspicuous phenocrysts of glassy quartz a salmon-colored perthitic feldspar in a black to dark-maroon, very aphanitic and often subconchoidally fracturing matrix
- Yr Rhyolite-Reddish-brown aphanitic porphyty containing as much as 25 perce enocrysts of white (albite) and pink (potassium) feldspar, and quartz, tocrystalline felsic groundmass. West of Ironton, equivalent luff rhyolite of Berry (1976) Ys Andesite and basalt-Dark-greenish-gray porphyry containing as much a percent phenocrysts of white feldspar having albite twinning,
- nphibole and magnetite, in very fine grained groundmass. West ronton, equivalent to Buck Mountain Shut-ins Formation of Ber chute—Dark-gray or brown porphyry consisting of abundant tabular dspar phenocrysts in a holocrystalline groundmass of feldspars a agnetite (locally as much as 20 percent by volume); some conta pyroxene or amphibol Yab Albite rhyolite—Mostly dark purple to dark gray aphanitic porpl -10 percent (occasionally as much as 25 percent) phenocrysts
- olorless albite with easily visible albite twinning, in a cryptocryst groundmass. Quartz latite and soda-rhyolite (Ys) of Pratt and others West of Ironton, includes Shepherd Mountain Rhyolite and informaunit 690 of Berry (1976)
- Contact-Approximately located Contact—Gradational: between residual units otted where concealed under water or residuum; bar and ball o vnthrown side. Note: Mine mapping in quadrangle has shown that r
- aults have strike-slip displacement as much as 5 times vertical displ However, strike-slip movements are not shown on this map b cannot be documented in surface exposures Active mine in the Viburnum trend Os Solution-collapse structure (sink hole)



gravity maxima and 1 minima (Densities in g/cc)

surface. (Densities in g/cc) Two-dimensional gravity models showing one possible upper Previous petrologic investigations have determined a density value of Survey.

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Magnetic Anomaly Map

Residual Magnetic Anomaly Maps



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





We digitized a geologic map (Pratt, 1985) and smaller filter. 8b (top right) shows a Bandpass (30-5km) filtered superimposed the igneous rock outcrops to better residual gravity map. Of note is the large decrease in the Taum Sauk Caldera, and large increases near the Missouri Gravity Low understand our Bouguer gravity maps and models (Figures and the Lake Killarney Caldera. 8c (bottom right) is bp (15-1km) 7a & 6). magnetic map. The circular features are more punctuated. The A Lacoste & Romberg Gravimeter and Topcon D-GPS unit large anomaly is nearly absent. 8d (bottom left) is bp (20-1km) gravity. Anomolies become more prevalent. And the Taum Sauk were used. anomaly has moved SF







Fig 6.1: Profile A-A' cuts across 3 significant anomalies, 2 Fig. 6.2: Profile B-B' highlights a series of smaller amplitude anomalies. (Densities in g/cc)

crustal density configuration of the St. Francois region. These 2.67g/cc for the granites of the St. Francois region (Hildenbrand, 1993). I models represent a first attempt at determining the density took measurements from samples collected by Dr. Thomas Plymate distribution and will be modified later. We are still collecting data (MSU) and found densities reflecting those used in the models. Variability to determine if the density value is the same along our three was higher than expected. The Elsey group of dolomites/sedimentary profiles. In Figs. 6.1 & 6.2 there the Shepherd Mtn Gabbro has rocks have been determined to have a density of 2.7g/cc (Hildenbrand, been found from core samples. This anomaly in the lower crust 1993). We tried to account for this in our profiles. We used varying accounts for such a low. Our model can be complicated with more densities for our sedimentary cover rocks as determined by geologic dikes, we are awaiting access to core from the Missouri Geological 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.



Fig. 6.3: Profile C-C' shows low amplitude anomalies. There is significant mafic dikes outcrop along this

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

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