

The Generation and Management of Museum-Centered Geologic Materials and Information

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ABSTRACT

This thesis integrates three disciplines: geosciences, computer science, and museum collections management. Although these are not commonly integrated, by developing their intersection this thesis uniquely contributes a much-needed system for effectively managing geological collections. The lack of effective organization and management of collections can result in a serious problem: not only is history lost, but so is the potential for collection of further data from documented samples using newer analytical techniques. Using the Department of Geosciences at Virginia Tech as a beta testing ground, the electronic geological management system, EGEMS, was developed (Chapter 2). A database such as EGEMS should provide ready access to useful information including, a material's provenance or current location, as well as any published analytical data. Past experiences volunteering in museums have allowed the author to design a system that is easily queried for such information. The organizational scheme and data model integral to the functionality of EGEMS was driven by direct experiences with geological research, in particular the electron microprobe analyses of Mn-rich minerals from the Hutter Mine, Virginia (Chapter 1). The final component of this thesis (Chapter 3) describes a facet of museum science that is most important—communication. This project records the development of a museum exhibit. Titled “The Search for the Mysterious Mineral,” this approach relies on pedagogical tools to engage the audience, and to illustrate how the scientific method used by a geologist is the same technique used in any problem solving. The exploration involved in these projects has lead to an enhanced understanding and appreciation for connections among generating, managing, and communicating geological information.

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CHAPTER 1: GENERATION OF GEOLOGIC INFORMATION

Manganese Deposits

The informational structure for any collection of materials is best understood through use of the materials themselves. Since one of the goals in designing EGEMS was to create a data model for research products, the first step was to perform geological research. The manganese deposit at the Hutter Mine in Pittsylvania County Virginia has a unique geological environment, and this research suggests could be the first identified natural occurrence of the rare Manganese Analog of Norbergite (MAN).

Mineral deposits rich in manganese (Mn) are commonly metamorphic, and many of them appear to have originated as zones of sea-floor manganese precipitates (Mn nodules) or as Mn-bearing carbonates of exhalative origin from submarine hot water vents. Metamorphism, either regionally or in contact events, greatly alters the deposit by means of oxidation and decarbonation reactions as well as metasomatic chemical interactions with the surrounding sea-floor sediments (Huebner, 1992). Particularly well-studied Mn-deposits include the Noda-Tamagawa Mine in Japan, the Franklin and Sterling Hill Mines in New Jersey, the Långban Mines in Sweden, and the Bald Knob locality in the piedmont province of North Carolina. The Hutter Mine, located in Pittsville, Virginia, (about 40 miles away along strike from Bald Knob in the Virginia piedmont) is a lesser known locality that also shows evidence for seafloor deposition and later metamorphism of Mn-rich precipitates. In the late nineteenth and early twentieth century Hutter operated as an iron mine. The ore was mostly magnetite, but the iron ore protolith contained lenses of manganese carbonate that were metamorphosed to assemblages with Mn-oxides, Mn-carbonates and a variety of Mn-silicates (Beard and Tracy, 2002).

One mineral group that is found in all of these deposits is the manganese humites. The manganese humites, like their Mg counterparts, are layered silicate structures. They exist on a silica continuum involving interlayering of Mn-olivine (tephroite – Mn_2SiO_4) layers with $\text{Mn}(\text{OH},\text{F})_2$ layers. There are 4 potential manganese humites on the continuum, the highest in Si being sonolite which has a layering ratio of 4 Mn-olivine:1 $\text{Mn}(\text{OH},\text{F})_2$, and the lowest in Si being the “Manganese Analogue of Norbergite” (MAN) which has a layering ratio of 1 Mn-olivine:1 $\text{Mn}(\text{OH},\text{F})_2$ (Francis and Ribbe, 1978; White and Hyde, 1982; Winter, 1983) (Norbergite has the least Si content of the Mg-humite mineral group.) MAN has not been officially named, or accepted, as a mineral because although it has been synthesized in the laboratory (Francis and Ribbe, 1978), it has yet to be found in nature.

MAN has likely been difficult to find because it requires a combination of low-Si and a high-F to form in natural parageneses. Manganosite (MnO), a rare mineral indicative of environments with low Si activity (Beard and Tracy, 2002), has been found at all of these Mn-deposits in mostly small quantities. At Noda-Tamagawa and the Hutter mine, however, larger amounts have been found. In addition, previous analytical work has discovered that the F in the manganese humites from the Hutter Mine increases as the Si content decreases. A few grains were even reported to have as high as 5 wt. % F (Tracy et al., 2002). If MAN exists anywhere, it is most likely to be found in MnO-bearing rocks with high F content, such as those at the Hutter Mine.

Coincidentally, the higher-Si manganese chain-silicate phases rhodonite and pyroxmangite (Mn-pyroxenoids) occur at Långban, Franklin-Sterling and Bald Knob, but not at the Si-poor Noda-Tamagawa or Hutter mines (Tracy et al, 2003).

Electron Microprobe Analysis

Using Electron Probe Microanalysis (EPMA), quantitative analyses were performed on polished thin sections from the Hutter Mine, loaned for this research by the Virginia Museum of Natural History (VMNH). Major and trace element chemical analyses were performed at Virginia Tech using a CAMECA SX-50 electron microprobe. This instrument was also used for Wave-length Dispersive (WDS) elemental mapping of Mn-humites and other minerals. Beam conditions for quantitative analysis of major and minor elements were 15 kV accelerating potential with a beam current of 20 nA. The WDS elemental mapping was typically done at conditions of 15 kV with a beam current of 300 nA. A combination of natural and synthetic standards was used, and ZAF-type matrix corrections were performed using the PAP protocol (Pouchou and Pichoir, 1984). The standards included Benson orthoclase (Si), synthetic Fe_2O_3 (Fe), natural Wollastonite (Ca), and Marjalahti olivine (Mg). Special standards used for the analyses of Mn-rich minerals in this study included natural Manganosite (98.5 wt% MnO) for Mn and synthetic MgF_2 for F.

The combined EMPA analyses and spectra from Energy Dispersive Spectrometry (EDS) aided in identifying which grains were manganese humites and which were not. Once this was known, traverses were set up across the manganese humite grains to obtain their compositional data (Figure 1). The excitation spot size was approximately $1\ \mu\text{m}$ and the traverses were set to collect data every 2-4 μm , depending on grain size and desired compositional resolution.

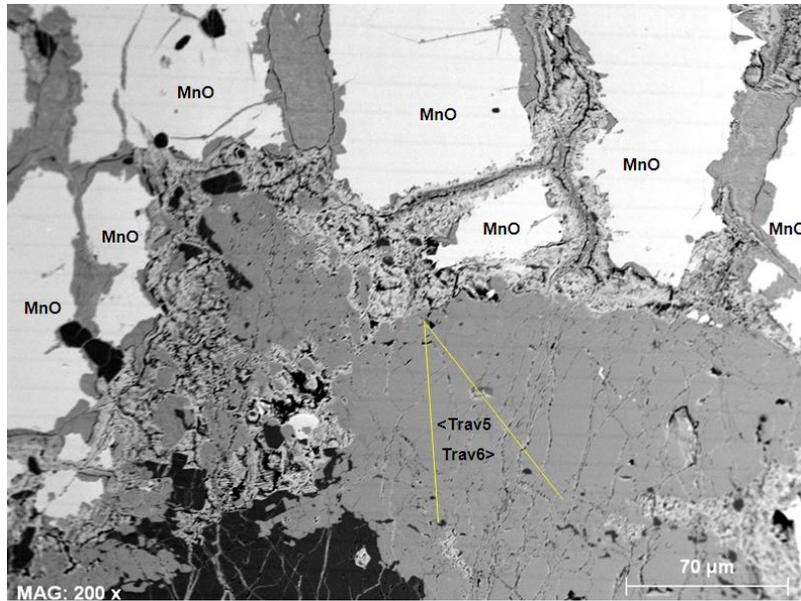


Figure 1. BSE image of Area 3 in thin section HM10 showing Mn-humite (medium grey), manganosite (MnO) (bright), Ca-Mn carbonate (black) and alteration to various Mn oxides along fractures (various greys). Locations of analytical traverses within Mn-humite indicated by yellow lines.

When the compositional data were recalculated to mineral formulas based on the number of oxygens (anhydrous) per formula unit for each mineral, it revealed the ratio of Mn-olivine to Mn(OH,F)₂ layers and thus identified where on the manganese humite continuum each analytical point fell. It should be noted that a Microsoft Excel spreadsheet was developed to recalculate these formulas, incorporating modeled amounts of non-analyzed H₂O by taking into account analyzed F. Figure 2 shows the compositional data from sample HM10, area 3, traverse 5, for which the backscattered electron (BSE) image is illustrated in Figure 1. In BSE images, the shading reflects average atomic weight of each material which is typically automatically scaled between black (low average atomic #) and white (high average atomic #). Thus in Fig. 1 manganosite has an average atomic weight of 35.47 ($54.94 + 16 = 70.94/2$ atoms in MnO = 35.47) and is bright, whereas CaMn(CO₃)₂ has average atomic weight of $215.04/10$ atoms = 21.5, and is very dark. For atomically lighter materials that absorb more electrons, the detector picks up a lower flux of backscattered electrons and so the grain shows up as very dark. The

opposite is true of heavier materials that reject more electrons and thus for which the detector picks more up back-scattered electrons and the grain appears brighter. It was puzzling at first that the spreadsheet showed variation in average atomic weight, that the BSE image did not, but it can be explained since the difference in average atomic weight across the manganese humite continuum is so minimal, compared to differences between humites and other minerals in the rock, and the BSE imaging auto-scales, making it difficult to show subtle but important differences.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	HM10		Color Key:	MAN	Alleghanyite	Manganhumite	Sonolite	Tephroite	(Closest to)					
2														
3	Sample No.	Trav 5 MnO	Trav 5 MnO	Trav 5 MnO	Trav 5 MnO	Trav 5 MnO	Trav 5 MnO	Trav 5 MnO	Trav 5 MnO	Trav 5 MnO	Trav 5 MnO	Trav 5 MnO	Trav 5 MnO	Trav 5 MnO
4	Analysis No.	2	4	6	8	10	12	14	16	18	20	22	24	26
5	SiO ₂	26.85	26.615	26.575	26.96	26.705	27.11	22.584	23.493	16.609	27.509	28.436	27.083	27.14
6	Al ₂ O ₃	0	0	0	0	0	0	0	0	0	0	0	0	0
7	FeO	0.506	0.478	0.421	0.492	0.438	0.427	0.443	0.402	0.408	0.551	0.385	0.46	0.479
8	MnO	65.921	65.459	65.563	65.156	65.335	65.305	64.709	64.127	57.097	64.998	65.697	65.967	65.708
9	MgO	4.482	4.633	4.682	4.662	4.63	4.792	3.194	4.078	2.103	4.13	4.36	4.285	4.297
10	CaO	0.115	0.097	0.132	0.089	0.079	0.099	0.105	0.186	0.298	0.064	0.079	0.089	0.063
11	ZnO	0	0.079	0	0.071	0.147	0.155	0.138	0.039	0	0	0.04	0	0
12	F	1.052	1.094	1.148	1.081	1.275	1.528	0.629	1.373	0.794	1.125	1.204	0.999	1.138
13		98.94	98.46	98.52	98.51	98.61	99.42	91.80	93.70	77.31	98.38	98.20	98.88	98.83
14	minus O=F	0.44	0.46	0.48	0.46	0.54	0.64	0.26	0.58	0.33	0.47	0.51	0.42	0.48
15	TOTAL	98.49	97.99	98.04	98.06	98.07	98.77	91.54	93.12	76.97	97.90	97.70	98.46	98.35
16	H ₂ O	1.14	1.12	1.11	1.13	1.08	1.02	3.43	1.88	#DIV/0!	0.79	1.09	1.14	1.10
17	Tot+H ₂ O	99.63	99.12	99.15	99.18	99.15	99.79	94.97	94.80	#DIV/0!	98.69	98.79	99.60	99.45
18														
19														
20	Formula Basis	12.9	12.9	12.9	12.9	12.9	12.9	5	8.8		16.9	12.9	13	13
21														
22	Si	3.009	3.003	2.998	3.028	3.020	3.049	1.083	1.955	0.000	4.044	3.004	3.053	3.068
23	Al	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
24	Fe ²⁺	0.047	0.045	0.040	0.046	0.041	0.040	0.018	0.028	0.000	0.068	0.037	0.043	0.045
25	Mn	6.257	6.254	6.265	6.198	6.257	6.219	2.629	4.520	0.000	8.091	6.323	6.298	6.291
26	Mg	0.750	0.779	0.788	0.781	0.781	0.803	0.228	0.506	0.000	0.905	0.739	0.720	0.724
27	Ca	0.014	0.012	0.016	0.011	0.010	0.012	0.005	0.017	0.000	0.010	0.010	0.011	0.008
28	Zn	0.000	0.007	0.000	0.006	0.012	0.013	0.005	0.002	0.000	0.000	0.003	0.000	0.000
29	F	0.373	0.390	0.410	0.384	0.456	0.543	0.095	0.361	0.000	0.523	0.433	0.356	0.407
30														
31	Mn+Mg+Fe+Ca	7.088	7.090	7.108	7.036	7.088	7.075	2.881	5.070	0.000	9.074	7.108	7.072	7.068
32														
33	Molecular Proportions													
34	SiO ₂ (60.09)	0.447	0.443	0.442	0.449	0.444	0.451	0.376	0.391	0.276	0.458	0.440	0.451	0.452
35	Al ₂ O ₃ (101.96)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
36	FeO (71.85)	0.007	0.007	0.006	0.007	0.006	0.006	0.006	0.006	0.006	0.008	0.005	0.006	0.007

Figure 2. Mineral Formula Recalculation Spreadsheet of Area 3 in thin section HM10. The formula basis for each probe point shows where on the manganese humite spectrum that point is. The spectrum is color coded from —MN” which is yellow, to —Tephroite” which is green.

Plotting the ratio of Si/total divalent cations against the distance along the traverses provided a useful way to discriminate between different ratios of Mn-olivine and Mn(OH,F)₂ layers in the crystal structure from point to point in analytical traverses. Figure 3 is a plot of data obtained from sample HM28, whereas Figure 4 is data from sample HM10 and includes data from the

traverse shown in Figures 2 and 3. The data in sample HM28, from multiple Mn-humite grains is homogeneous and plot far from the MAN line. The data from HM10 however, of two traverses in the same grain, is heterogeneous and contains 4 points that plot very near the MAN line. Similar degrees of heterogeneity occur in multiple grains from sample HM10. The paucity of compositions appropriate to MAN does not provide a strong case that thicker lamellae of MAN are present in the alleghanyite or manganhumite. Deviation of Si/Sum of Divalent Cations for Grain D, however, suggests that very fine lamellae of either alleghanyite or MAN are present in the manganhumite host grain. Additional investigation, perhaps with XRD, TEM, or SIMS, is needed to resolve this question.

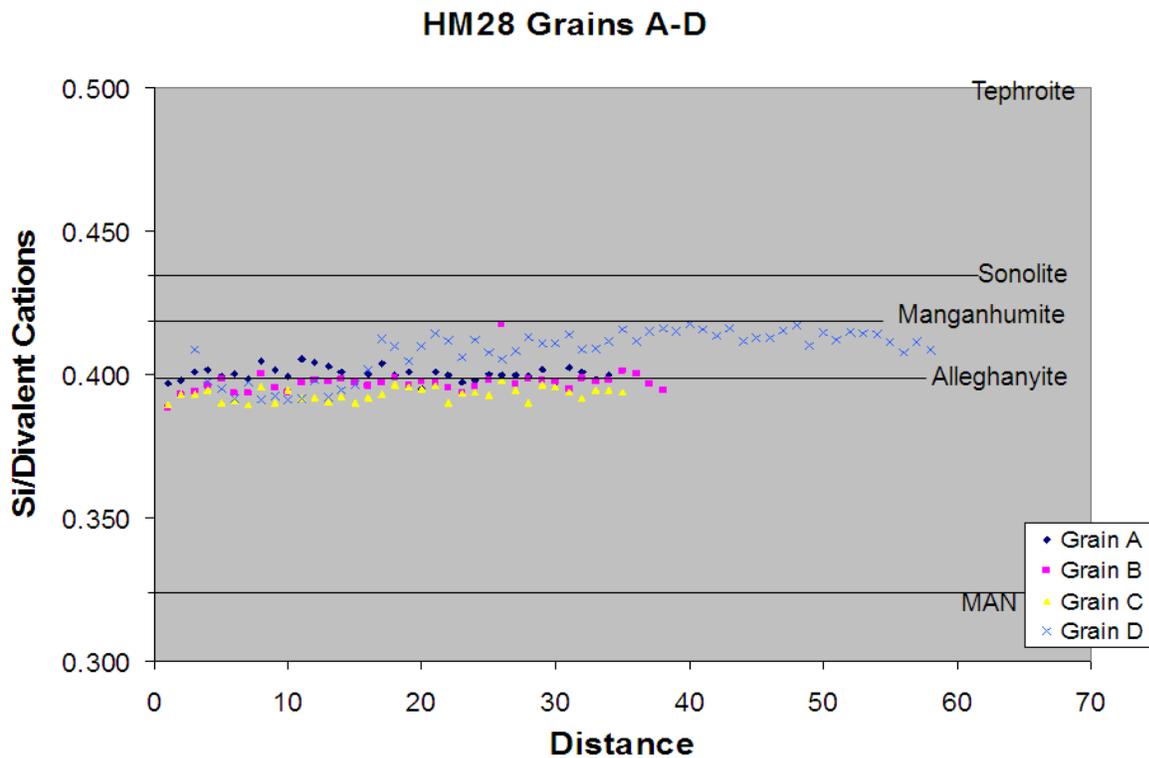


Figure 3. Plot of the ratio of Si/Total Divalent Cations versus distance along an analytical traverse for grains in thin section HM28. Values of Si/Divalent Cations are shown for various Mn-humite mineral species as horizontal lines. The compositions fall mostly between Alleghanyite, and Manganhumite, and are homogeneous.

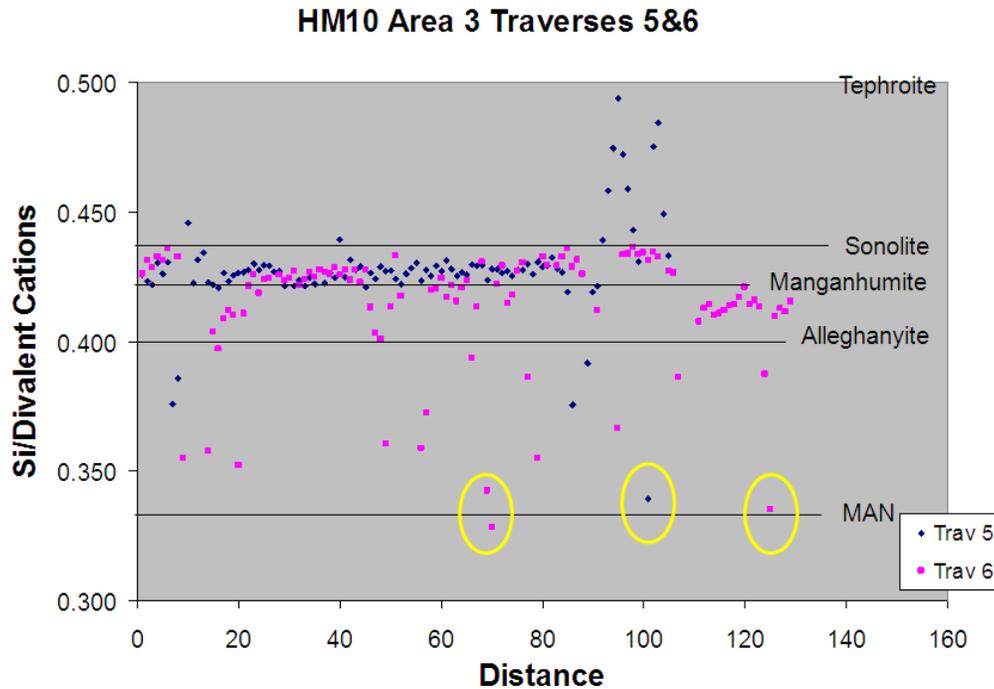


Figure 4. Plot of the ratio of Si/Total Divalent Cations versus distance along an analytical traverse for grains in thin section HM10, Area 3. Values of Si/Divalent Cations are shown for various Mn-humite mineral species as horizontal lines. The points that fall closest to MAN in composition are circled in yellow.

Results and Conclusions

Among several hundred EMPA analyses, a few values from sample HM10 do appear close to the composition of MAN (Figure 4). Although this suggests that MAN may be present at the Hutter Mine, the paucity of such data points must be regarded as providing an ambiguous result for now. Because the mineral manganosite is abundant at the Hutter Mine, and the presence of MnO is one indicator of the extremely rare conditions MAN requires, additional searches at this locality and similar deposits are warranted. Further analytical work, and an expanded investigation by Robert Tracy and Jim Beard, will be incorporated into this study. The results will help to determine if MAN can or does exist at the Hutter Mine.

CHAPTER 2: MANAGEMENT OF GEOLOGIC MATERIALS AND INFORMATION

Computers and Collections Management

From ordinary-looking rocks to rare and exquisite mineral specimens, people all around the world have been collecting geological materials for centuries. For these collections to last, however, they require care and maintenance. Before computers this task required a large amount of time, energy, and staff support. Consequently the information for many older collections was never recorded or kept up-to-date. Fortunately the information-technological revolution, beginning in the late 1970s, created an opportunity for individuals and institutions to store and organize information digitally using a database. This opportunity transformed the process of collections management and it is largely as a result of databases that we have access to many geological collections today.

Historically, museums have recognized and appreciated the importance of collections management. Before the technological revolution, however, museum methods of record-keeping were less than optimal. “Museum records often lacked important information, catalog cards were sometimes duplicated, records were written with inconsistent vocabulary throughout, cross-referencing was rare, and cards often went missing or there were cards for which the associated object was missing” (Carpinone, 2010). Museums, however, had an obligation not only to preserve the objects in their care, but to provide an acceptable level of accessibility to those objects and the documentation relating to them” (Sarasan and Neuner, 1983). Even before computerized collections management became standard practice, larger museums, such as the Smithsonian, realized the potential for computers to help solve these problems (Carpinone,

2010). In 1970 the Smithsonian Institution began a second project on digital collections management, stemming out of its first attempt SIIR (Smithsonian Institution Information Retrieval). This second project was named SELGEM (SELf-GENerating Master) and it was used for general information processing, including collection documentation (Chenhall, 1975). These collections management systems were the some of the most advanced of their time and they paved the way for many decades of improvements.

Probably as a result of their primary educational mission, but certainly exacerbated by the lack of time and resources, the geology departments of most universities did not develop these kinds of systems. As geologic materials accumulated, the collections became more disorganized and less well documented. Many departments have since rid themselves of older collections for which data were lacking, and are now storing materials with more care. Even so, there is still a major lack of organization and effective management and many collections are at risk because their only record is the ephemeral knowledge stored in a few people's minds.

Today, geology departments in the US are at a turning point in history because the National Science Foundation (NSF), a major source of funding for geological research, has declared that "Proposals submitted or due on or after January 18, 2011, must include a supplementary document of no more than two pages labeled "Data Management Plan". Never before have geology departments had the collections management obligation that museums have had, but that is changing now. The rest of this chapter examines how museums undertake collection management, and how "museum solutions" can be applied to the collections that reside in college and university geology departments.

What is “collections management” and why is it so important? The American Association (AAM) of Museums refers to the management of collections as “stewardship”. The AAM Accreditation Program, in their 2005 report, defined collections stewardship as:

Stewardship is the careful, sound, and responsible management of that which is entrusted to a museum’s care. Possession of collections incurs legal, social, and ethical obligations to provide proper physical storage, management, and care for the collections and associated documentation, as well as proper intellectual control. Collections are held in trust for the public and made accessible for the public’s benefit. Effective collections stewardship ensures that the objects the museum owns, borrows, holds in its custody, and/or uses are available and accessible to present and future generations. A museum’s collections are an important means of advancing its mission and serving the public (AAM, 2005).

This definition encapsulates multiple facets of any museum, and I argue that a university department could, with the right tools, meet the standards set by this statement, and through museum examples. The most essential tool for implementing this stewardship process is a relational database with a user interface. This part of my thesis research aimed at developing this tool, and in the end resulted in the creation of the electronic geological management system (EGEMS).

Initial Research and Needs Assessment

EGEMS is the end product of a repetitive “research-troubleshoot” cycle: it is a database solution for managing geological materials and although it was originally designed for university geology departments, it can be used by museums, personal collectors, or anyone who wants to manage their materials better. The beginning stages were dominated by background research, and included a 5 week course on Microsoft Access, a multitude of meetings with the programming expert in the Department of Geosciences at Virginia Tech., learning about digital libraries and

relational databases from a variety of professionals, and investigating existing software packages. EGEMS was built and runs on FileMaker Pro software because it is one of the easiest database development programs to use, it works on both the Mac and PC platforms, and it has instant web publishing capabilities. The latter part of the year involved more feedback from potential EGEMS users and beta testing of the various functions of EGEMS. The entire project took over 300 hours and as it has turned into a potential commercial enterprise, the improvements are ongoing.

In order to assess which database components were applicable to university departments, I first researched the databases *Emu*, *Past Perfect*, and *Re:discovery*, since these have been most commonly used in History and Natural History museums (Carpinone, 2010). It seemed the main disadvantage of these databases was that they all had many unnecessary fields and were trying to capture more information than anyone has time to weed through, or to enter (Figure 5). In addition, these systems only provide one main screen for viewing, entering, and searching this information.

OVERWELMING

EMPTY

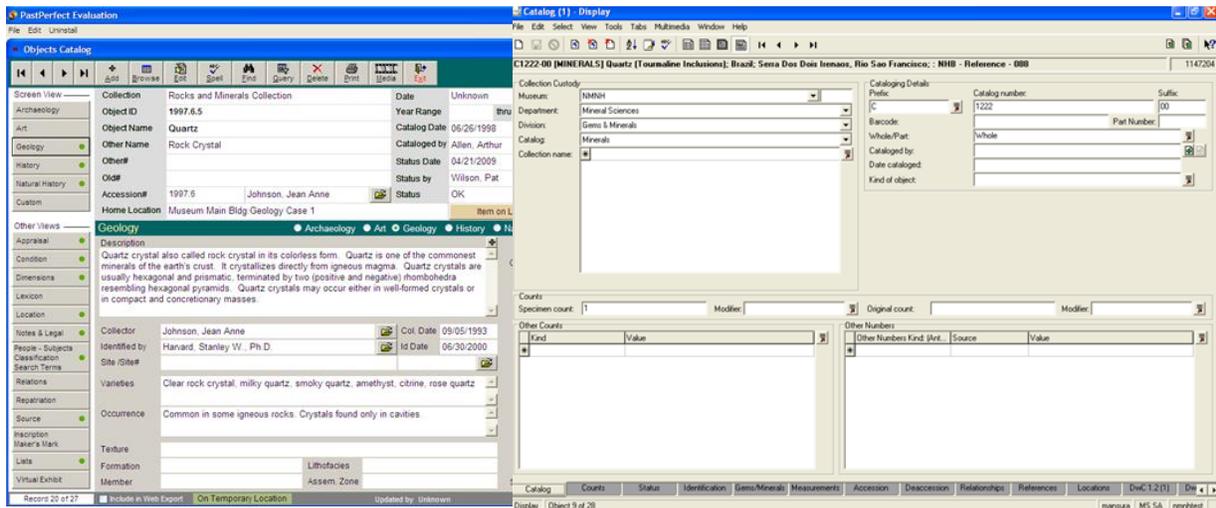


Figure 5. Comparison of current database programs illustrating user-unfriendly layouts.

It seemed these database systems were built without much attention being paid to how the user would interact with the interface. In designing EGEMS, the user's needs were constantly being re-evaluated and the interface updated accordingly. For example, in the very beginning, to verify which fields would be most necessary, a Needs Assessment was distributed to the Department of Geosciences at Virginia Tech (Appendix A). The assessment was designed to look at data entry fields for geological research products. Of the department's 7 main topics of research, all are represented by people chosen for this assessment (Table 1).

Discipline of the Geosciences	Number of People
Paleontology	2
Sedimentation and Stratigraphy	3
Mineralogy and Crystallography	5
Hydrogeology	3
Geomorphology	2
Petrology	2
Structural Geology	2
Geophysics	6
Geochemistry	6
32 people total	

Table 1: Needs Assessment Demographics

The fields chosen for the Needs Assessment were originally part of Table 4 –“Data Categories Commonly Used to Catalog Different Object Classes” in Robert Chenhall’s book, *Museum Cataloguing in the Computer Age*. Figure 6 shows the results of this evaluation.

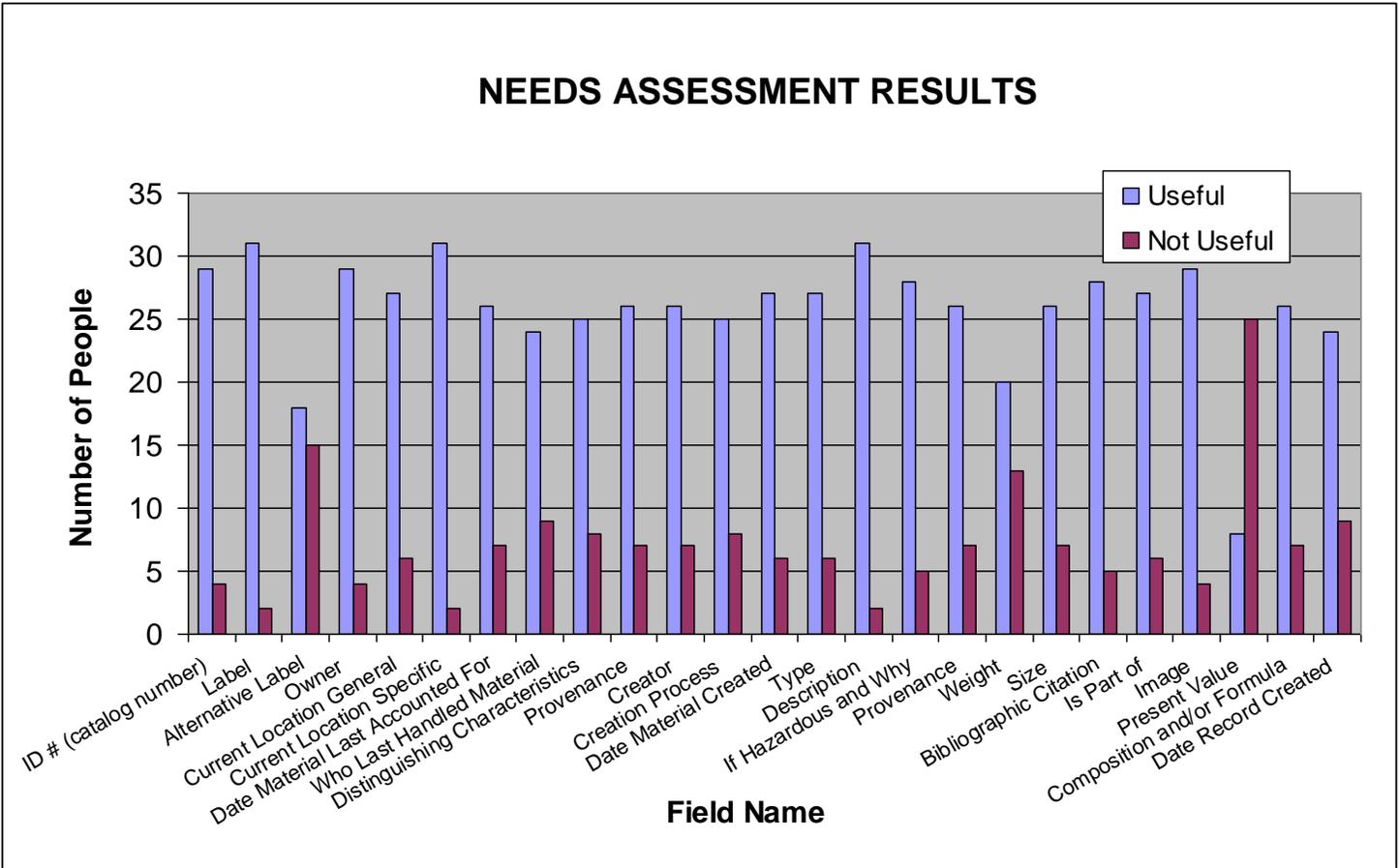


Figure 6. Graph of Needs Assessment results illustrating usefulness of fields. These particular fields were intended for recording information on research products, but many of the fields are applicable to other materials as well.

One of the questions in the Needs Assessment asked “Do you feel EGEMS will benefit you?” Of the 33 people who completed the assessment, 21 said “yes” and 12 said “no”. The following questions asked them to explain in more detail why they chose the answer that they did, some of the responses are given in Table 2.

Please explain your answer to the question above. (Do you feel EGEMS will benefit you?)
An organized system for geological materials would benefit everyone
Very little of our "collection" is presently useful as its disorganization makes it unreasonable to search for sample material
Well, in the study of a site it would be pretty cool to know directly who has which samples (specially for sites where access to samples is limited).
Not really, but I do believe it is a really important tool to have for geoscientists.
I would like to search EGEMS for limestone/dolostone rocks in our collection, maybe some from a specific time in the Precambrian (Mesoproterozoic).
I think it would allow me to find samples a LOT more easily.
It would be a great system, but I do not know if I will need to use it.
I have a hard time keeping track of the minerals I use to teach lab. It would also be nice to have a database to refer to if I need any museum samples to use for class as well.
It would save me the time and money associated with going out to collect samples, unwittingly duplicating those already in our collection
It would make it much easier to know what is already in the department versus what I would need to collect on my own

Table 2: Needs Assessment Quotes

Overall, the Needs Assessment verified that EGEMS would benefit a large part of the department in creating greater accessibility for geological materials in our department. The original design of EGEMS was a direct result of this assessment. Like most collections

management systems, EGEMS has both a front end and a back end. The back end is usually referred to as the *relational database*, while the front end is called the *user interface*. The next section of this chapter details various views of the user interface and the reasoning behind their design. The following images have been taken from the Museum of Geosciences at Virginia Tech, (altered for security purposes) since that is where EGEMS was beta-tested.

EGEMS User Interface

The user interface of EGEMS was designed to be intuitive and user friendly. As EGEMS was developed, a variety of people, including computer scientists, geoscience professors and graduate students, and museum collections specialists, were encouraged to review EGEMS. It is through this interdisciplinary and collaborative effort that EGEMS is now implemented in the Department of Geosciences at Virginia Tech and will hopefully be available soon to help anyone who wishes to manage their geological materials better.

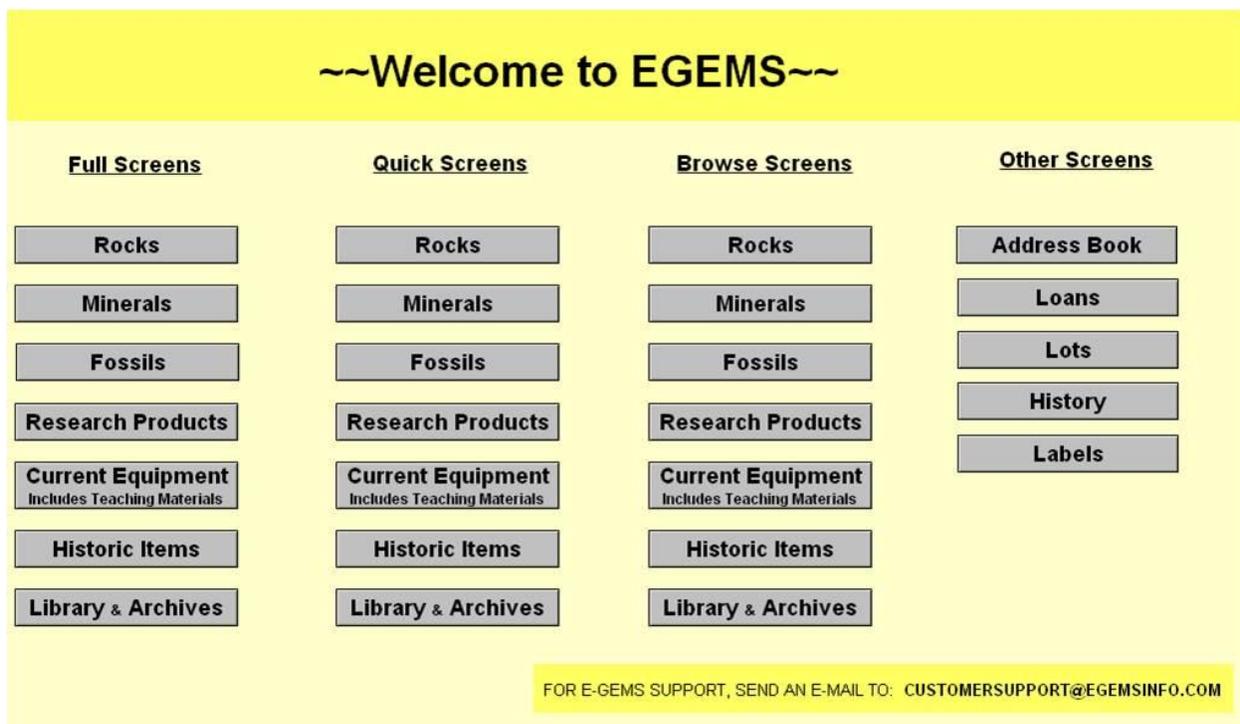


Figure 7: Home Screen for EGEMS split up by screen type.

Figure 7 shows the EGEMS *Home Screen* which is broken into 3 different types of screen views: Full Screen, Quick Screen, and Browse Screen. A *Home* button can be found on every one of these, and will bring the user back to this screen. Users can access all of the main screens from the *Home Screen*.

Also accessible on all pages is the Navigation Bar (Figure 8). The Navigation Bar can have up to 5 buttons: Home, Address Book, Print Preview, Search, and New Record. The *Address Book* is where contact information can be found for anyone who donated or sold to the institution, maintains responsibility for materials in the database, or collected or created material in the collections. *Print Preview* is a unique function of EGEMS where the user can print a copy of the screen they are viewing, save to a PDF format, or save to an excel format. The *Search* button allows the users to search any field or combination of fields. Lastly, *New Record* creates a blank record automatically filled in with the next record number. To be certain every user understands and can use this bar, the symbols are universal and if a user mouses over the buttons, a *Help* dialogue will pop up. (Figure 8)

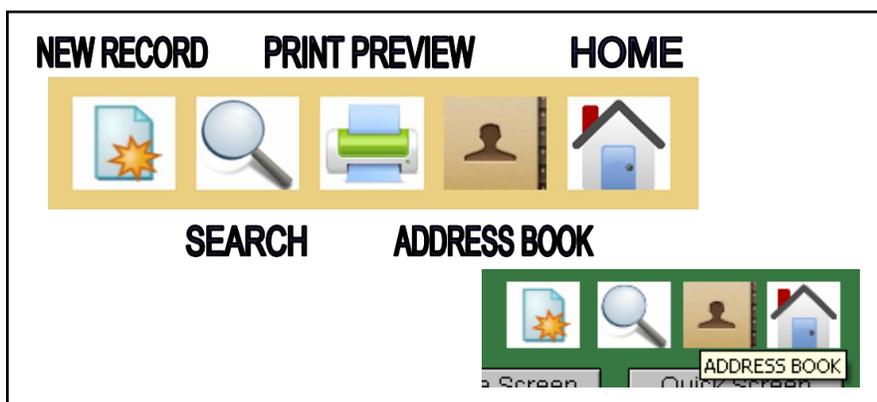


Figure 8. *Navigation Bar* for EGEMS illustrating the buttons a user might see, and their universal icons. Also, on the bottom right of this figure, the help pop-up is being shown as an example, on any of these buttons, if the user hovers their mouse over them, a help pop-up is available.

As mentioned in the first section, I made the observation while reviewing existing collections management programs that they had many unnecessary fields, and gave users only one main screen to enter, view, or search data. As a result of this observation, EGEMS was built with multiple screens including the quick screen view (Figure 9). This screen avoids having either too much empty space or data overload by recording just the essentials. Much of the data entry in museums is typically done by novice volunteers. The consequence of this is that they commonly do not enter all of the important information, or they enter more than is needed and thus time and effort are wasted. The quick screen in EGEMS solves these problems, making data entry by volunteers more efficient. This screen also allows any user to view the important facts about a material on one page.

ROCKS QUICK SCREEN

Record Summary **mylonite gneiss-United** Record Number **14**

Browse Screen Full Screen

Label Info

Collection Name **Bill Henika Collection**

MoGs/DoGs ID? Prefix ID Number Used in teaching? Yes

Private Label(s) **CHK-744** Previous Label(s)

Acquisition Info (If NOT self collected)

Source Source Type Date Acquired

Description Info

Rock Classification **metamorphic** HAZARDOUS? Yes No

Rock Type **mylonite gneiss** Important Characteristics

General Description **silver gray foliated mylonite gneiss with asymmetrical** Fossils? Yes No

Description Comments **300 point modal analysis**

Origin/Collection Site Info

Country **United States** Province/State County **Floyd** Locality Name

Location Info

Maintained By **Bill Henika** If not kept in home location:

Current Location **0001 Derring Hall VT**

Who Has the Material Currently **Bill Henika**

Home Location (General) **Martinsville, VA** Location Comments

Building-Room **VMNH Room 24441** Date Returned or Moved from Current Location

Cabinet-Drawer To fill in more loan information click here **Loan Info**

Associated Documents? Yes

Assigned to a Lot? Yes

Figure 9. *Quick Screen* for Rock Material, where only the essential information is permitted, making data entry more efficient and intuitive. Should a user wish to go to another screen, they can click any of the grey buttons on this screen to take them there.

EGEMS also has a Browse Screen. If a user is searching for a specific material, the Browse Screen is the best place to start, and it is likely to be most familiar to users who commonly search the internet. As an example, the view in Figure 10 is a listing of all of the minerals the Museum of Geosciences has from North Carolina. The top left yellow circle highlights a green pie diagram that tells what proportion of the total number of records meets the search criteria. In this case it is 287/8549. The bottom circle highlights information in the “important characteristics” column. The important characteristics for this particular mineral indicate that there is a second mineral, fairfieldite, associated with the main mineral of this record, fluorapatite. A user can check if there are any other associated minerals simply by selecting the record’s row and clicking on the “full screen” button at the top right of the screen. This will take them to the full screen view of that record (Figure 11).

Record #	Collection Name	Main Mineral Name	State/Province	Locality Name	Description	Important Characteristics	Euhedral
8670	MoGs Minerals	Fluorapatite	North Carolina	Foote Mine	light tan crystals in		<input type="checkbox"/> Yes <input type="checkbox"/> No
8671	MoGs Minerals	Rhodochrosite	North Carolina	Foote Mine	isolated tan-orange		<input type="checkbox"/> Yes <input type="checkbox"/> No
8672	MoGs Minerals	Earlshannonite	North Carolina	Foote Mine	brownish-orange-		<input type="checkbox"/> Yes <input type="checkbox"/> No
8673	MoGs Minerals	Laumontite	North Carolina	Foote Mine	white elongated		<input type="checkbox"/> Yes <input type="checkbox"/> No
8674	MoGs Minerals	Analcime	North Carolina	Foote Mine	cream colored		<input type="checkbox"/> Yes <input type="checkbox"/> No
8675	MoGs Minerals	Analcime	North Carolina	Foote Mine	cream colored		<input type="checkbox"/> Yes <input type="checkbox"/> No
8676	MoGs Minerals	Beryl	North Carolina	Foote Mine	one easily visible		<input type="checkbox"/> Yes <input type="checkbox"/> No
8677	MoGs Minerals	Fairfieldite	North Carolina	Foote Mine	light tan crystals		<input type="checkbox"/> Yes <input type="checkbox"/> No
8678	MoGs Minerals	Pyrite	North Carolina	Foote Mine	tiny pyrite crystals		<input type="checkbox"/> Yes <input type="checkbox"/> No
8679	MoGs Minerals	Eosphorite	North Carolina	Foote Mine	yellow-tan crystals		<input type="checkbox"/> Yes <input type="checkbox"/> No
8695	MoGs Minerals	Fluorapatite	North Carolina	Foote Mine	small tan crystals		<input type="checkbox"/> Yes <input type="checkbox"/> No
8696	MoGs Minerals	Eosphorite	North Carolina	Foote Mine	not easily visible	rare	<input type="checkbox"/> Yes <input type="checkbox"/> No
8697	MoGs Minerals	Fluorapatite	North Carolina	Foote Mine	gray crystals, white	also has Fairfieldite	<input type="checkbox"/> Yes <input type="checkbox"/> No
8698	MoGs Minerals	Brannockite	North Carolina	Foote Mine	tan	short wave UV to see	<input type="checkbox"/> Yes <input type="checkbox"/> No
8699	MoGs Minerals	Vivianite	North Carolina	Foote Mine	black, green		<input type="checkbox"/> Yes <input type="checkbox"/> No
8700	MoGs Minerals	Fluorapatite	North Carolina	Foote Mine	light tan circular		<input type="checkbox"/> Yes <input type="checkbox"/> No
8701	MoGs Minerals	Cryptomelane	North Carolina	Foote Mine			<input type="checkbox"/> Yes <input type="checkbox"/> No

Figure 10. *Browse Screen* for Minerals showing results of a search. The circle at the top of the screen is highlighting the results of the search, and the circle toward the bottom is highlighting a selected record.

The full screen view (Figure 11) for every material in EGEMS is tabbed across the top. The default tab *Description* has information similar to the browse screen, such as *Important Characteristics*, but it also has other information such as *Size*, *Weight*, *Geologic Age*, and *Associated Minerals*. The associated minerals section in Figure 11 is highlighted to show that fairfieldite has been selected but that there are no other associated minerals for this record.

MINERALS FULL SCREEN

Record Summary **Fluorapatite-United** Record Number **8697**

Label Info | Acquisition Info | **Description** | Origin/Collection Site | Location Info | Value | Images | Documents | Citations | Loan History | Lot Info

Mineral Group Name: Add New Mineral Group Name

Main Mineral Name: **Fluorapatite** Add New Main Mineral Name

Mineral Formula: **Ca5 (PO4)3 F**

Other Mineral Name:

Quality:

Condition:

Number of Pieces:

Crystal Form:

Crystal Size: **medium**

Euhedral: Yes No

Specimen Size: **6x5x1** in centimeters

Oversize?: Yes No

Weight: (Specify units used)

Description Comments:

Geologic Age:

Absolute Age:

HAZARDOUS?: Yes No

General Description: **gray crystals, white fairfieldite crystals**

Important Characteristics: **also has Fairfieldite**

Cutter (if a cut gem):

Associated Minerals In Decreasing Abundance:
(If your mineral name can't be found in the drop down box, please click the "add new main mineral name" button at the top of this screen to add it to the list.)

Mineral 1: **Fairfieldite**

Mineral 2:

Other Associated Minerals:

Last Modified On: 8/21/2011 3:27:49 PM Last Modified By: sarah timm
Date Record Created: 7/28/2011 Created By:

Figure 11. *Full Screen* for Minerals highlighting the *Associated Minerals* fields under the *Description* tab.

If a user wishes to know more about fairfieldite, EGEMS provides formulas for all main mineral names in the corresponding authority file (see below). There are multiple ways to obtain this formula but the easiest is illustrated in Figure 12. From the Full Screen the user would click the *Search Record* button at the top and type into the *Main Mineral Name* field the name of the mineral they would like to know more about, in this case, fairfieldite. Notice how the *Main*

Mineral Name field has a drop down box (Figure 12). This is an authority file. An authority file helps to keep data consistent. Look again at Figure 10, and note that —North Carolina” is spelled out completely. If a user tried to search for —NC” it would display an error message because that is an invalid value. This means that for every field with an authority file, a value must be selected from the drop down list. Once the user has searched for the mineral of interest, if it is in the database then the formula will be given beneath the *Main Mineral Name* field. Notice in Figure 12 how the yellow arrow points to the formula for fairfieldite.

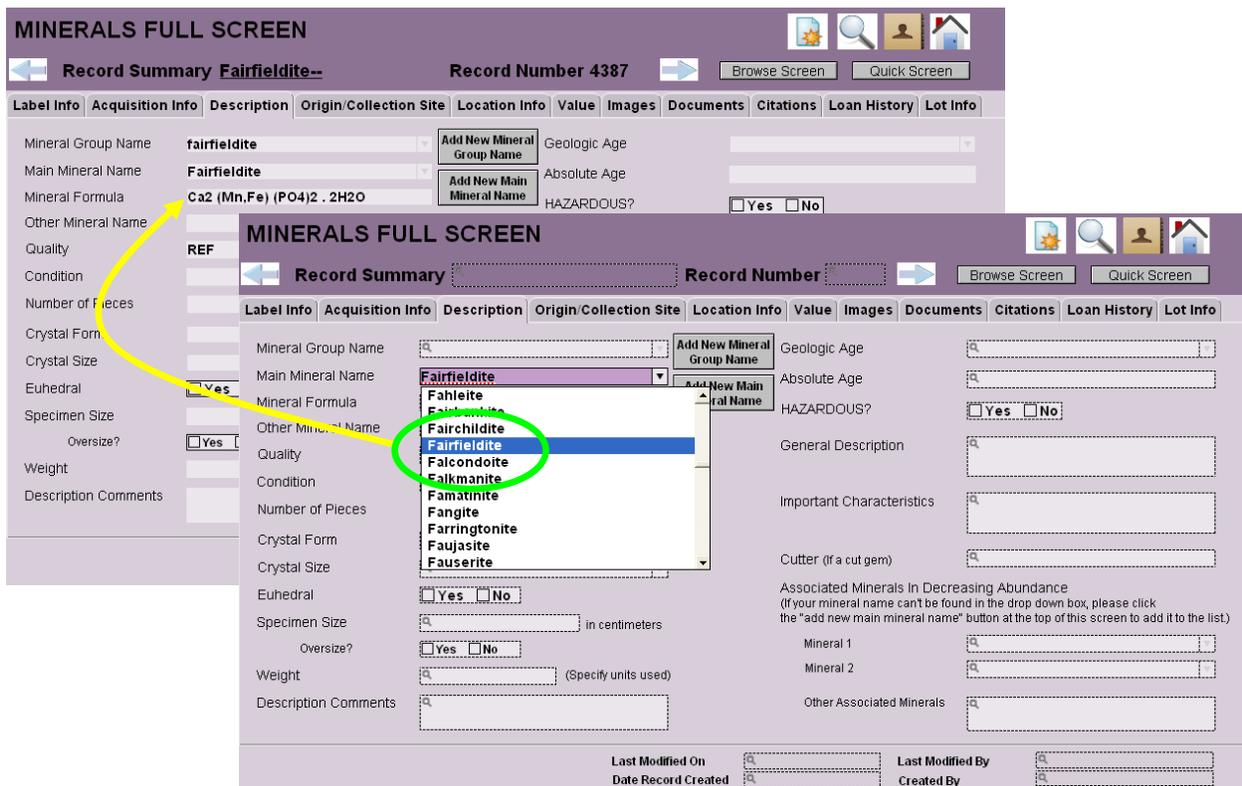


Figure 12. Flow chart showing how to find a mineral formula using a dropdown menu/authority file.

If a user would like to add a new mineral name, perhaps because they are inputting data on a mineral specimen and the mineral does not show up in the authority file, then they need to click

on the “add new main mineral name” button in the middle of Figure 12. This button will open a screen where new mineral names and formulas can be added (Figure 13).

LIST OF MAIN MINERAL NAMES & FORMULAS		Back to Minerals	Back to Rocks			
Ezcurrite	Na ₂ B ₅ O ₇ (OH) ₃ · 2H ₂ O					
Eztlite	Pb ₂ Fe ₆ Te ₄ O ₁₅ (OH) ₁₀ · 8H ₂ O					
Fabianite	Ca B ₃ O ₅ (OH)					
Faheyite	(Mn,Mg,Na) Be ₂ Fe ₂ (PO ₄) ₄ · 6H ₂ O					
Fahleite	Ca Zn ₅ Fe ₂ (AsO ₄) ₆ · 14H ₂ O					
Fairbankite	Pb TeO ₃					
Fairchildite	K ₂ Ca (CO ₃) ₂					
Fairfieldite	Ca ₂ (Mn,Fe) (PO ₄) ₂ · 2H ₂ O					
Fairchildite	(Ni,Mg) ₄ Si ₆ O ₁₅ (OH) ₂ · 6H ₂ O					
Falkmanite	Pb _{5.4} Sb _{3.6} S ₁₁					
Famatinite	Cu ₃ Sb S ₄					
Fangite	Tl ₃ As S ₄					
Farringtonite	Mg ₃ (PO ₄) ₂					
Faujasite	(Na,Ca) (Si,Al) O ₂ · 1.4 H ₂ O					
Fauserite	Mn SO ₄ · 7H ₂ O (?)					
Faustite	Zn Al ₆ (PO ₄) ₄ (OH) ₈ · 5H ₂ O					
Fayalite	Fe ₂ SiO ₄					

Figure 13. List of Main Mineral Names and Formulas, highlighting the mineral Fairfieldite and its formula.

Using a combination of screens and the “modify last find” function of FileMaker Pro, a user can quickly narrow down a search. This is extremely useful for users who search hierarchically. For example, if a user searches in full screen for all of the fossils in the family *brachiopoda* (Figure 14a), the search will return 134/1152 (Figure 14b). If the user then selects from the *Records* menu the option *Modify Last Find*, (Figure 14c) then the previous find is brought up and the user can provide criteria for a narrower search. In this example, the class *articulata* is searched in addition to the original family search. This narrows the results to 98/1152 (Figure 14d). If the user then wishes to constrain the search further, this can be done by repeating these same steps.

This search is further narrowed by adding the criterion that the genus must equal *Onniella* (Figure 14e) and with this final criterion the search is narrowed to 3 records (Figure 14f). If the user searched for records whose *Genus Species* field contained *Onniella* from the start, the same 3 records would be found. Data input and data searching are the predominant uses of most databases. In addition to these common functionalities, EGEMS can benefit users through a variety of less common, and even unique, functions.

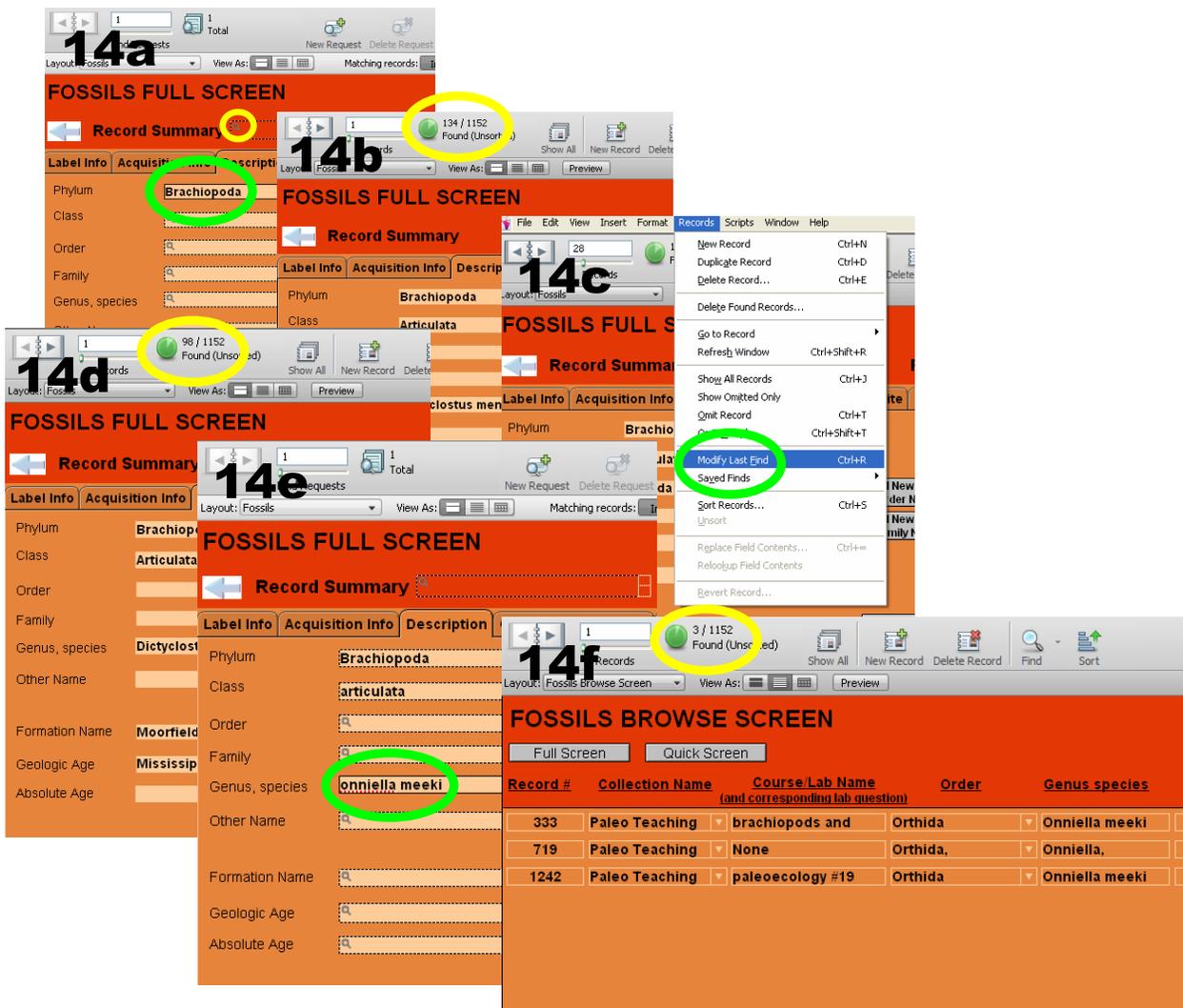


Figure 14. Example of a hierarchical search in EGEMS, out of 1152 records, this search has narrowed the results to 3.

Because EGEMS was originally designed for research collections, it has the capability to record information specific to research products. Research products are geological materials that can be used for research or were derived from research. Examples of research products include: thin sections (polished, or covered), billets, experimental powders, synthesized materials, etc. It is common for research products to have accompanying analyses, and since FileMaker has simple tools for uploading many file types, EGEMS is perfect for these materials.

To attach a file to a record, a user would first select the “documents” tab in the full screen view, and then click the rectangular button toward the center that says, “click to add new document” (Figure 15a). This will take the user to the *Document Browse* screen for that particular material. The user should then select the *New Record* button, depicted as a white piece of paper with a yellow star (highlighted with the green circle in Figure 15b). This will create a new line at the bottom of the list. The user then must enter the record number of the material the file is associated with, and any information about the file. Finally, if the user right-clicks on the empty box under the column labeled *Document* a dropdown menu will appear (Figure 15b). From this menu the option *Insert File* should be selected. Once the file has been chosen, it will automatically upload to that record (Figure 15c). In this example the file was in a .gif format, but other file types such as the Excel and Word documents shown in Figure 15c may be uploaded as well. To open and view one of these files the user needs only to right click on the document and select the last option from the dropdown menu, *Export Field Contents*. This will download the document to the desktop where it can be opened with the appropriate application. Since the steps for inserting and exporting are not intuitive, and the user interface in EGEMS was designed to be

intuitive, detailed instructions have been added to these and any other screens with less than intuitive functions. The instructions are highlighted with the yellow arrows in Figure 15.

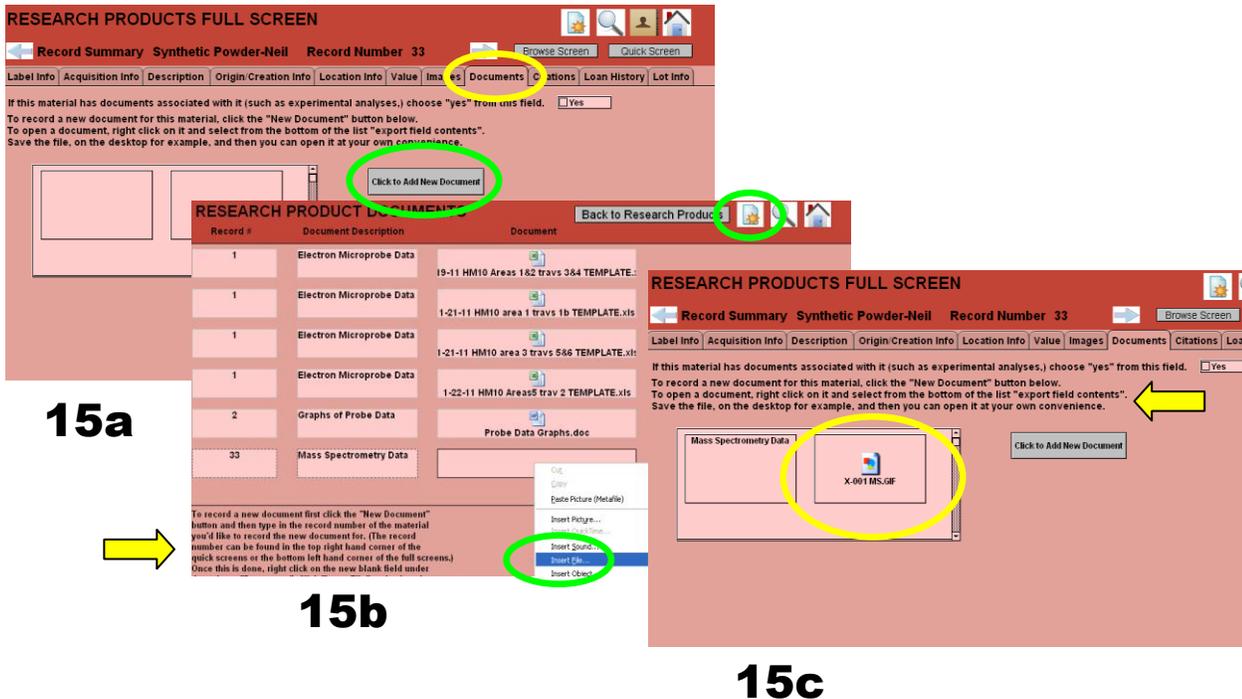


Figure 15. Flow chart illustrating steps to insert a document, in EGEMS. The yellow arrows are highlighting where instructions can be found.

In addition to inserting documents, EGEMS also allows users to insert images. This can be very helpful as it gives researchers an idea of what the material looks like. If someone forgot to document a detail about the object, perhaps the copper was corroded, or the plate was chipped, this would become immediately apparent in the photo. It is also good confirmation, once the specimen is found, that it is in fact the correct one.

Especially for research products, images can tell more than just the physical description of the object. The first record in research products is one of the thin sections analyzed for the work on the Hutter Mine samples that was described in Chapter 1. Using the *Photo Info* field, highlighted

with a yellow circle in Figure 16, information has been provided for each photo. As a result, if a researcher were to read the information associated with these images, he or she would learn that this slide contains a rare mineral named manganosite (MnO) and a manganese humite. This information was obtained through work with an electron microprobe, but a researcher who could see all of this in EGEMS would be more likely to work on research stemming from this, rather than “re-inventing the wheel”.

The user friendly button *Insert Image* was created to allow a user to easily insert an image into EGEMS. By simply clicking this button, a menu will pop up that allows the user to select an image from the files on that computer (Figure 16). The image must be one megabyte or less, or EGEMS will display an error message. Once the user has selected the desired image, as long as it is the appropriate size, it will automatically attach to that record.

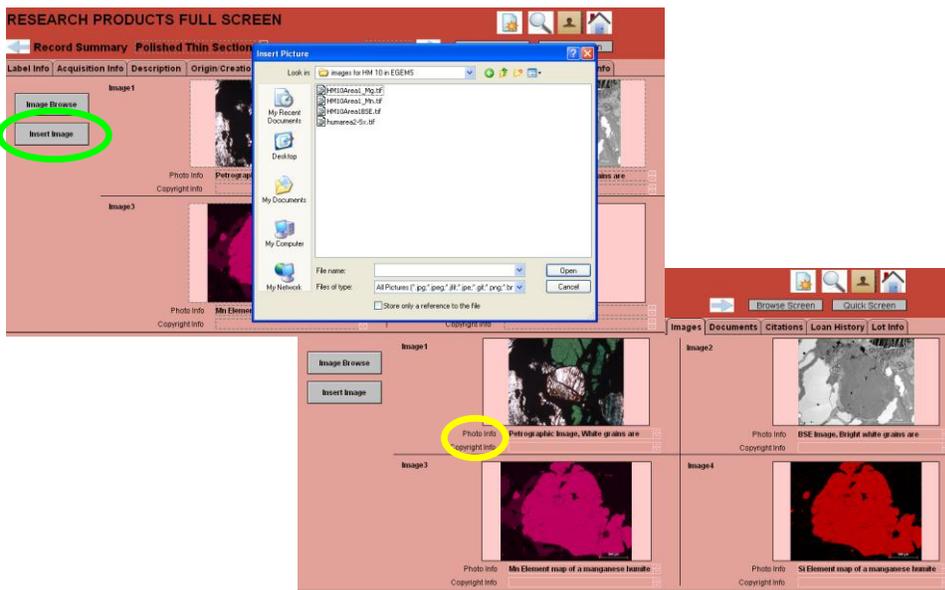


Figure 16. Flow chart illustrating steps to insert an image in EGEMS. The images in this figure are from the samples studied in Chapter 1.

A user may want to see all of the images for one material type, for example to compare quality, or just to see if each object has been photographed. To do this, the user would click on the button above *Insert Image* that is titled *Image Browse* and is circled in green in Figure 17. This will pull up a browse screen for the images of that material, where the user will then be able to view and search multiple records on the same screen (Figure 17). In this instance, the browse screen is for rocks, and has images from microscope to outcrop scale.

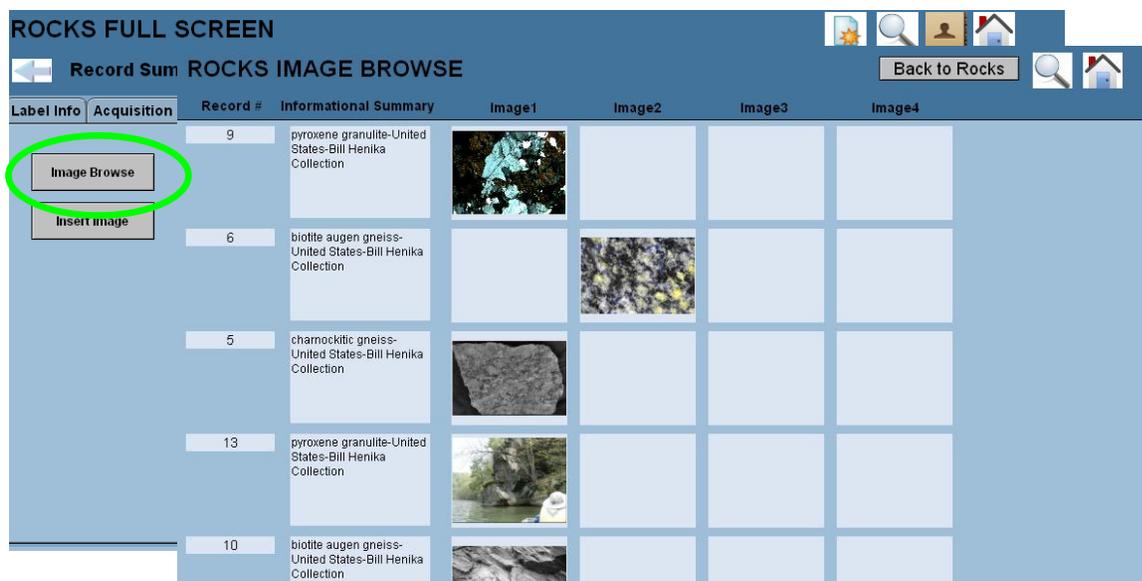


Figure 17. *Image Browse Screen* for Rocks illustrating how this feature of EGEMS can be used to communicate information about specimens on a variety of scales.

Record 33, the record used in the flow chart for inserting a document, is the first synthetic research product to be documented with EGEMS or any other database program reviewed for this project. Until recently, research products were not highly valued, and as a result many were lost or discarded. Since many famous geological localities have been “collected out,” fallen victim to development, or shut down due to unsafe conditions, preserving previously collected and documented specimens from these localities is a priority. What is left of these specimens is

typically housed in educational institutions and collectors' homes. Research products, such as the synthetic powder in record 33, typically cost a lot of money to create. Records of, and access to, such materials through EGEMS may provide a significant cost-saving for institutions and research funding agencies.

Figure 18 lists the fields which make up the table for research products. The yellow circles highlight fields new to geological databases. When these fields are filled in, as they are in Figure 19, they provide a lot of important information. For example, if a researcher were looking up research products with the word "lamellae" in the description, the researcher would find this record if the original user included this term in the observations. From the other information given, it would also be known which minerals occur in the polished section and the percentage of each one. Under the *Origin/Creation Info* tab, the researcher would see who collected the rock this material was derived from, and its original locality (Figure 19). If the original collector were listed in the Address Book, that person could be contacted to find out if the original rock still exists.

Accession Date	Date Evaluated	Label Comments	Provenance
Accession ID	Date Material Created	Label Price	Purchase Price
Accessioned By	Date Record Created	Location Comments	Record Number RP
Aquisition Comments	Date Record Modified	Location Summary	Room
Assigned to a Lot	Description	Maintained By	Size
Associated Materials	Description Comments	Material Type	Source Name
Availability Status	Evaluator	Modal Analysis	Source Type
Cabinet	Experimental Conditions	Other Observations	Starting Materials
Change ID	Formula	Oversize	SUMMARY
Collection Name	Hazardous	Prefix	Type Research Product
Creation Process	Home Location General	Present Value	Value Comments
Creator	ID Record Number	Previous Labels	Weight
Currency	Image	Private Labels	Who Created Record
Date Acquired	Important Characteristics	Product Use	Who Last Modified Record

Figure 18. List of fields for Research Products in EGEMS. The yellow circles are highlighting innovative fields new to geological databases.

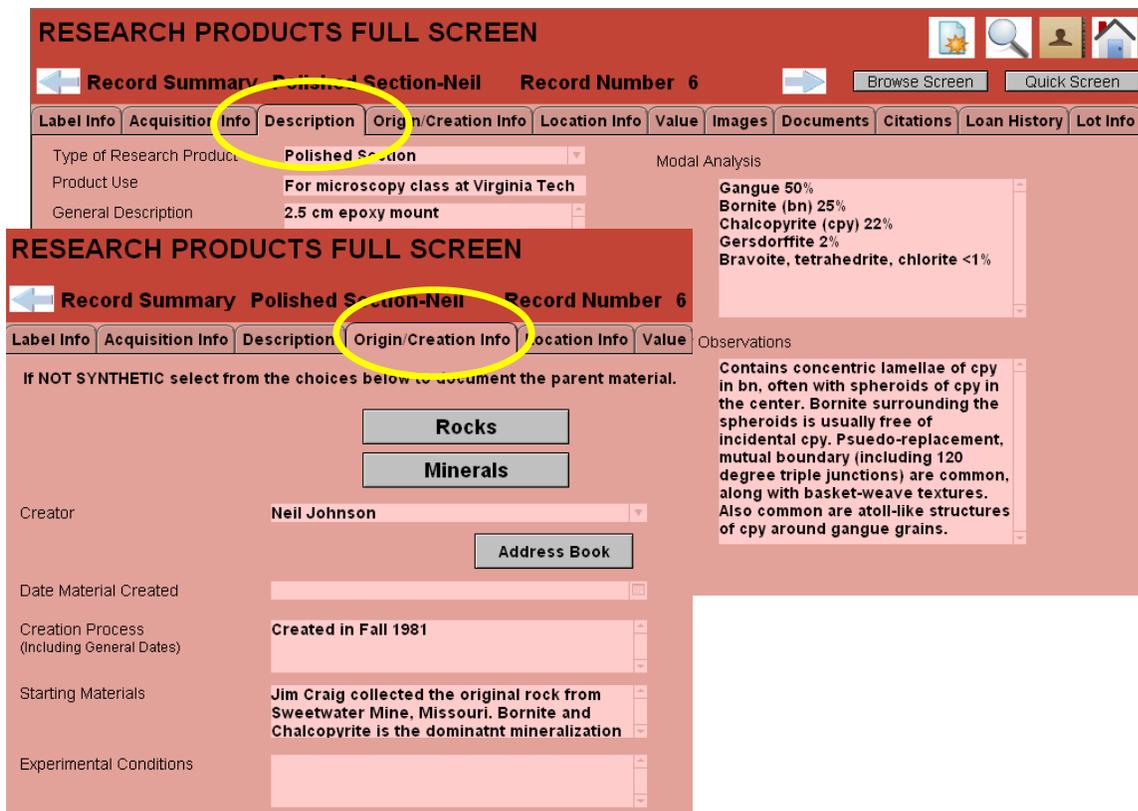


Figure 19. *Full Screen* for Research Products showing how researchers can communicate to other researchers through EGEMS detailed information about their specimens.

The other way to find out if a research product, or any material, is associated with another record in EGEMS is to select the *Lot Info* tab in the full screen view. This will take the user to the *Lots* screen. Lots records relationships between materials in EGEMS. In this case, the relationship is between the research product and its parent rock (Figure 19). The research product is record 31, a polished section, and the rock is record 16, hydrothermal vein material. EGEMS is intentionally designed so that detailed petrologic information is always stored in rock records, and analytical data associated with research products is stored in research product records. Through the creation of a Lot, these 2 pieces of information can be combined, and a larger picture for both materials can be seen (Figure 20).

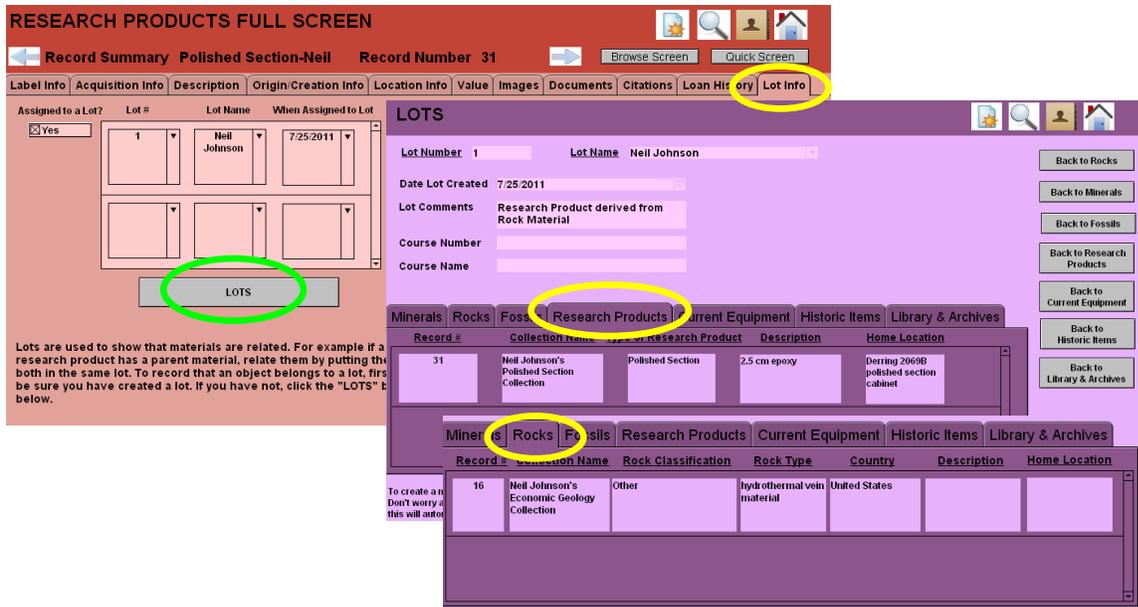


Figure 20. Flow chart illustrating how to use Lots to capture a relationship between materials in EGEMS.

The only other way to relate different types of materials in EGEMS, is through the *Loan Screens*. This is used to capture all of the information associated with incoming or outgoing materials (Figure 21). The loan records capture basic information including who the materials were loaned to and when, as well as detailed information about how the materials were used while on loan. From the *Loan Information Screen* a user can also access the *Loan Report*. The *Loan Report* summarizes the loan information and is printer friendly (Figure 20).

Loans also capture changes to the *Current Location* fields. When the loan has been returned, however, the record will only show the home location of the material. If a user wishes to see the history of loans for a particular material, they can view this in the full screen view, under the tab *Loan History* (Figure 22).

Loan Number 3 Loan Name Denver Fall 2011 Date Printed 2/12/2012

Who Loaned To Sarah Timm Material Use Exhibit

Who loaned From MoGs Course Number

When Loaned Out 7/11/2011 Number Reached Kids 25 Educators Other 25

Current Location Denver, CO Loan Comments RETURNED TO MUSEUM 9/30/11 by Sarah Timm Also in this loan there

When Returned 9/30/2011

MINERALS

Record #	Collection Name	Mineral Group Name	Main Mineral Name	Country	Description	Home Location
575	MoGs Minerals	calcite	Rhodochrosite	U.S.A.		c88
5028	MoGs Minerals		Eudialyte	Russia		lr9
6017	MoGs Minerals	garnet	Spessartine	U.S.A.	cut stone oval	SsW14
7755	MoGs Minerals	calcite	Rhodochrosite	South Africa		SsW14
7929	MoGs Minerals					
8425	MoGs Minerals					
8485	MoGs Minerals					
8493	MoGs Minerals					

Page 1

LOAN INFORMATION Printable Loan Report Loan Creation & Browse Screen

Loan Number 3 Loan Name Denver Fall 2011

Who Loaned To Sarah Timm Material Use Exhibit

Who loaned From MoGs Course Number

When Loaned Out 7/11/2011 Number Reached Kids 25 Educators Other 25

Location When on Loan Denver, CO

Scheduled End Date Loan Comments RETURNED TO MUSEUM 9/30/11 by Sarah Timm Also in this loan there is a Mangan-

When Returned 9/30/2011

If your loan contains more than 15 of one material type you will need to create another loan. For example if your loan was "Pretty Rocks and Minerals" you could create "Pretty Rocks and Minerals continued". This is so you will be able to print all of the materials belonging to the loan.

Mineral Rock Fossils Research Prod Current Equipment Historic Items Library & Archives

Record #	Collection	Mineral Group	Main Mineral	Country	Description	Home Location
575	MoGs Minerals	calcite	Rhodochrosite	U.S.A.		c88
5028	MoGs Minerals		Eudialyte	Russia		lr9

Back to Loan Info

Back to Rocks

Back to Minerals

Back to Fossils

Back to Research Products

Back to Current Equipment

Back to Historic Rems

Back to Library & Archives

Figure 21: Flow chart showing how to access the *Loan Report Screen* from the *Loan Information Screen*.

When I returned from exhibiting at the Denver Gem and Mineral Show, detailed in Chapter 3, I set up my exhibit in the Museum of Geosciences at Virginia Tech. Since the borrowed specimens were no longer with me in Denver, but had not yet been returned to their home locations, I created a second loan for them. This is reflected in the loan history of record number 575, a rhodochrosite displayed in the exhibit. Notice how the original loan for the Denver Show has a return date, but the exhibit in the Museum of Geosciences does not (Figure 22).

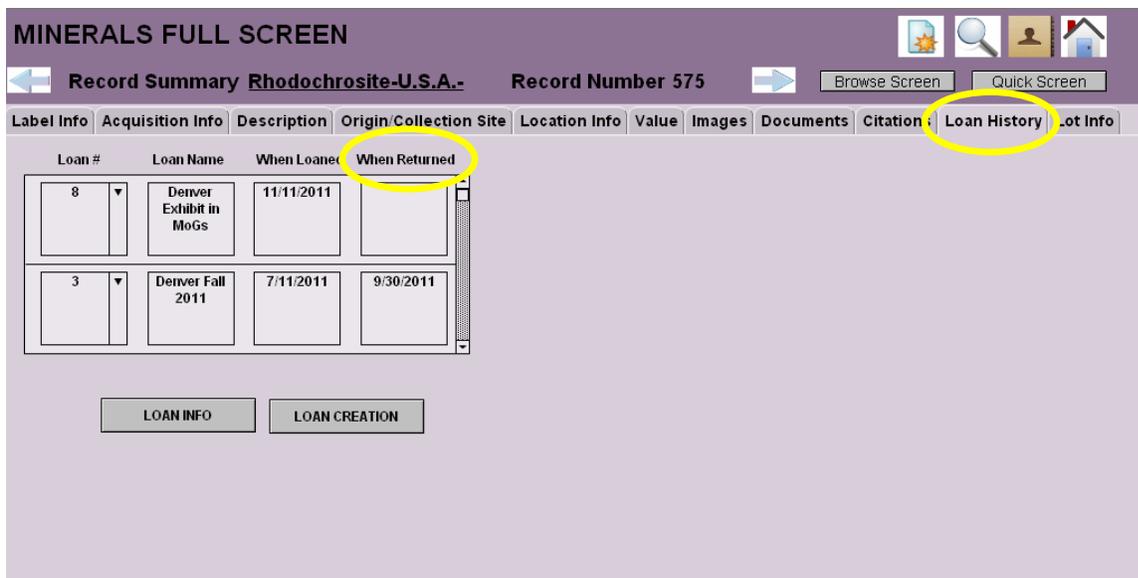


Figure 22. Loan History for Minerals in EGEMS

Another important, and exclusive, function of EGEMS is the Change History function. The *Change History Screen* records who changed which record and when. It does this through a script that runs after any main record field has been altered in any way. The script triggers a pop-up message that says “Do you want to save these changes?” (Figure 23). A user has the option to select “no” as a way to revert the record to the way it was when it was originally opened. If the user selects “yes”, then the change is recorded in the history. For most fields the history doesn’t tell the user what field changed, only that something in the record did. For very important fields, however, such as ID number or location, the actual change will be recorded. This enables a user who changes a field in error to know how to correct it back. In Figure 23 the yellow brackets are highlighting changes made to record 4.

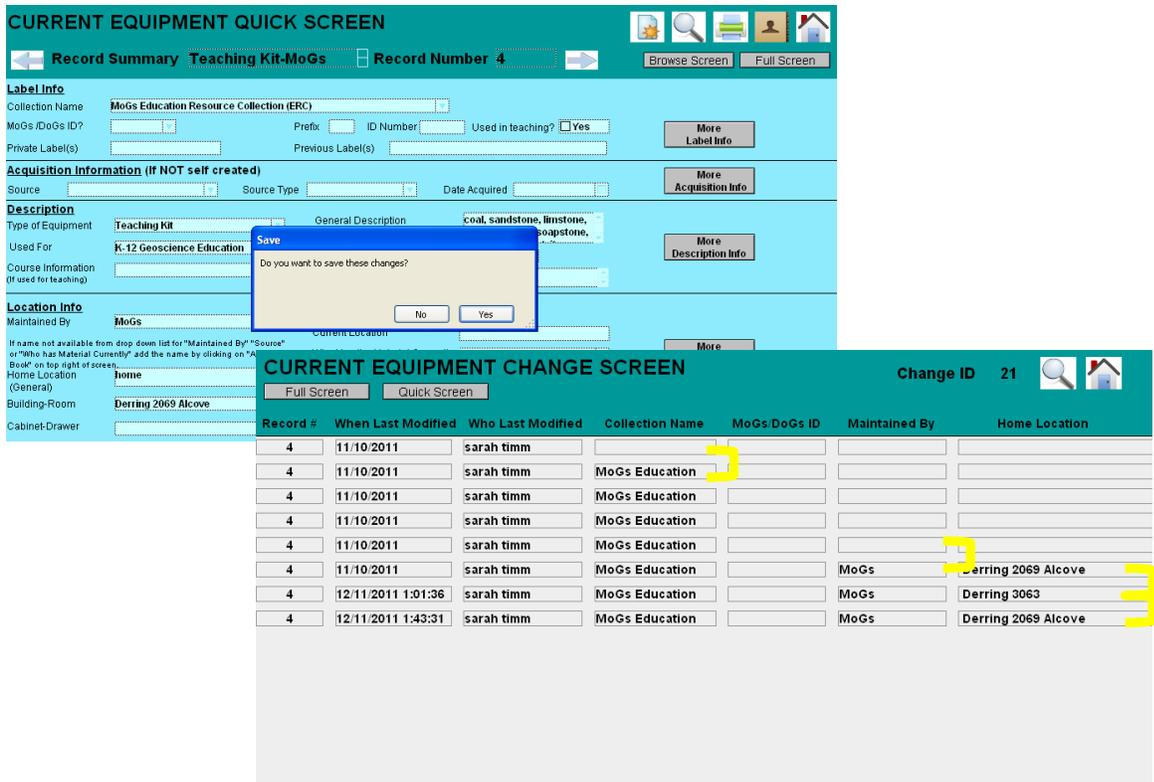


Figure 23. Flow chart illustrating steps to save changes in EGEMS. The yellow brackets are highlighting changes made to record 4.

EGEMS is unique in that it is the first database with the ability to record research products and to create a history which is viewable by all users at all security levels. It is also the first database for geological materials to take into account the needs of university departments, museum professionals, and private collectors in the same database. A good example of this is specimen and tray labels (Figure 24). These labels were modeled after the labels in the Museum of Geosciences at Virginia Tech. Professors and private collectors should keep detailed labels with their materials, but may not be lucky enough to have a program with a pre-made label template like EGEMS. Museums always have detailed labels accompanying their specimens, and these differ depending on whether specimens are on display or in storage. The label screens in EGEMS have zoom buttons to make reading the labels easier (Figure 24). It is also possible to view all of

the labels or only one, and to search by loan number. Depending on what the user needs, a user may view/print multiple labels, or only one. This is particularly useful if traveling with specimens, as when I exhibited in Denver. By having extra copies with me, should a specimen have gone missing, I would have had all the information about it with me.

ROCK TRAY LABELS

Full Screen
Quick Screen

Zoom In
Zoom Out

View Single Record
View All Records



Back to Labels

MoGs ID #	VT Museum of Geosciences	
Maintained By	Llyn Sharp	Locality Name
Imp Characteristics		Country
		Province
Rock Class	Igneous	Source Name
Rock Type	granite	
Specimen Size		Source Type
Description	Pink gray black and white granites	Date Acquired
# of Pieces		Home Location
Used For Teaching	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No	Derring 2040
	E-GEMS Rec Number	2

MoGs ID #	VT Museum of Geosciences	
Maintained By	Bill Henika	Locality Name
Imp Characteristics	Isolated	Country
		United States
		Province
		Virginia
Rock Class	Metamorphic	Source Name
Rock Type	mylonite gneiss	
Specimen Size	4.5x3x10	Source Type

MINERAL SPECIMEN LABELS

Full Screen
Quick Screen

Zoom In
Zoom Out

View Single Record
View All Records

To display tray labels for a particular loan, search by

Mineral Name	Quartz
Mineral Formula	Quartz
Country	Greece
Province	Serifos
Locality Name	Mega Xhorio
Source Name	
Source Type	
MoGs ID #	3069

Mineral Name	Halite
Mineral Formula	Halite
Country	Canada
Province	Saskatch
Locality Name	P.C.S. Lanigan
Source Name	TYSONS'
Source Type	
MoGs ID #	3070

To display tray labels for a particular loan, search by the loan number here.

Figure 24. Specimen and Tray Labels in EGEMS exemplifying various levels a user can zoom. This is very helpful when working the labels because the text is very small.

The goal for the final version of EGEMS was to be as intuitive and user friendly as possible. Along the way I asked for constructive criticism from a variety of people including: computer scientists, geoscience professors and graduate students, database programmers, and museum collections specialists. If feedback indicated that a part of EGEMS wasn't user-friendly, then more help pop-ups and instructions were added. The final section of this chapter explains the user assessment created for EGEMS and its outcomes.

Evaluation and User Assessment

To be sure EGEMS was an intuitive and user-friendly database solution, 6 potential users were asked to voluntarily complete an assessment of EGEMS. These volunteers represented the diversity of potential EGEMS users and include a Graduate Research Assistant (GRA), a Graduate Teaching Assistant (GTA), an Undergraduate Research Assistant, an Emeritus Faculty member, an active Professor, and a Museum Professional. The assessment was split into two parts: the first part assessed the ease of navigating the user interface, whereas the second assessed how efficiently EGEMS could aid users in finding physical objects within the Department of Geosciences.

The first question in Part 1 of the assessment asked the volunteers to begin by acquainting themselves with the different screens of EGEMS by navigating freely. Once they felt comfortable enough, they were asked to rate the overall appearance of EGEMS on a scale from 1-10. (1 being “very poor” and 10 being “well done”) The results of this question are graphed in Figure 24, and they show that overall the appearance of EGEMS rated by a variety of people, most of which were seeing EGEMS for the first time, averaged to about an 8.

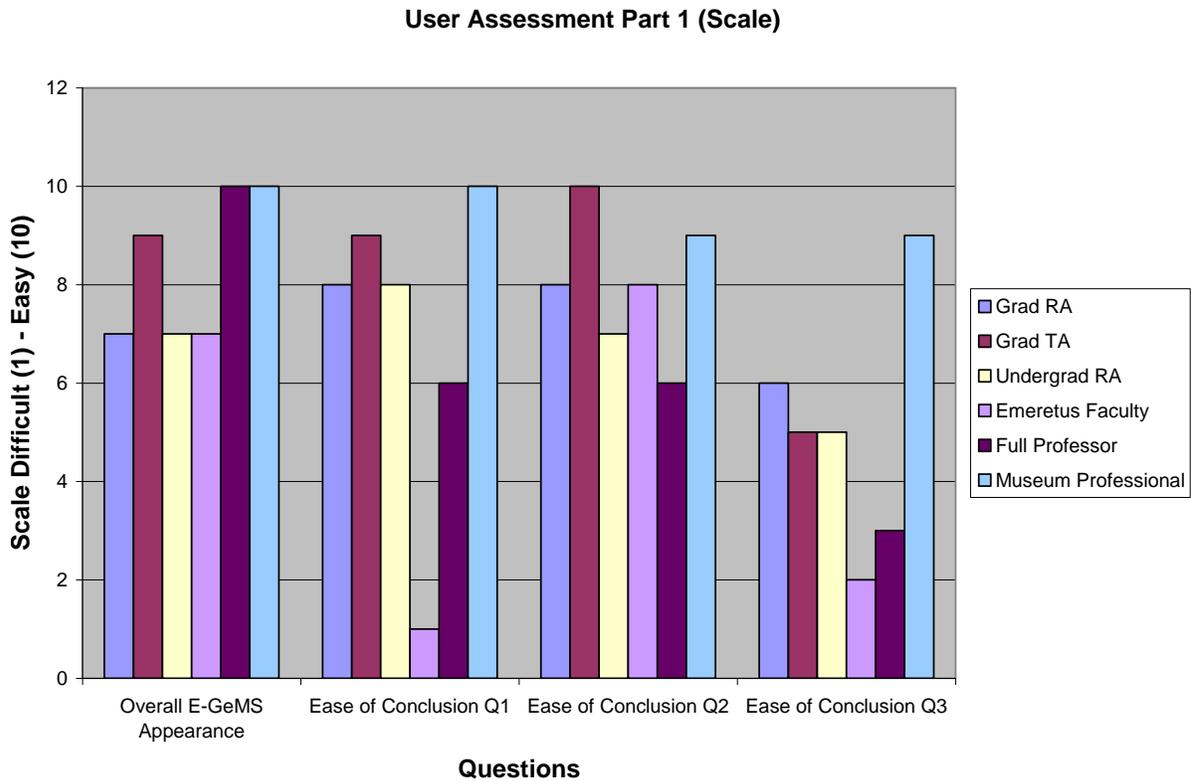


Figure 25: Graph of User Assessment Results for Part 1. The ratings illustrate how well done the volunteers felt the appearance of EGEMS was, as well as the ease of which they came to conclusions for questions 1-3.

The next three questions followed a repeating format; section –a” involved data in EGEMS with a specific right or wrong answer, section –b” was a multiple choice question asking the volunteer which screens they used to come to their first conclusion, and lastly, section –c” asked them to rate the ease with which they found the answers. Questions were chosen which specifically challenged the user. The results were surprisingly very mixed. Some people used the correct functions and processes yet came to the wrong answer, some people tried several processes before finding the correct one and thus the correct answer, and a few people had little difficulty and arrived at the correct answers without giving details on how they found them. The feedback that was ultimately received indicated that if the volunteer was accustomed to using a database

system, as the Museum Professional and GTA were, then it was much more intuitive for them, but if the volunteer was less computer savvy and/or not familiar with databases, as were the Emeritus Faculty member, and the Professor, then the process was less intuitive. These latter volunteers were asked what could be done to aid less knowledgeable users like themselves. Responses suggested that the help guides which pop up when a field label or button is hovered over did indeed point users in the right direction, and more of them were requested. Responses also indicated that the repeated trial and error, which led to some low ratings in Part 1 (Figure 25), were due to unfamiliarity with the system, and users might benefit from a tutorial of some kind. As a result of these suggestions, many more help pop-ups were added, as well as instructions, to the places that gave people the most trouble. A demo was also created to provide an introduction to EGEMS.

The screens chosen in Section “b” of these questions were especially important because multiple screens were purposely created to combat the disadvantage of most existing systems that give users only one main screen to enter, view, or search data. Although the differences are subtle, the pie chart below shows that the full screen was used the least and the quick screen was used the most, with the browse screen falling somewhere in between (Figure 26). Since the quick screen has all of the most important information in the most readable format, and our culture appreciates achieving their goals in the fastest and easiest way, it is not surprising that it was used the most. The full screen would probably have been used even less had question 3 not required it to obtain the correct answer.

Percentage of Screen Use

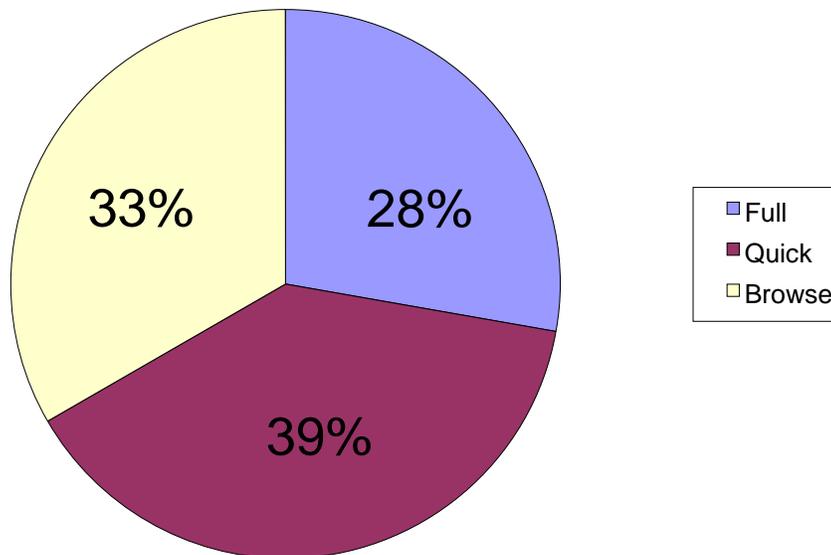


Figure 26. Pie chart illustrating percentage of screen use for the User Assessment of EGEMS.

For Part 2 of the assessment various members of the department collaborated with me..

Assessors were told that in order to test the ease of physically locating materials in the department, verification that the volunteer did successfully find the material would be required.

Part 2 was a bit of an experiment, but it seemed to work out satisfactorily. In contrast to the variability the ratings show in Part 1, the time in which the volunteers were able to find information on materials in EGEMS, contact the person maintaining these materials, obtain a response from this person, and if possible go see the physical object, was consistent across the volunteers. These times are graphed logarithmically in Figure 27. Question 2 took the least time because the 4 volunteers who completed Part 2 took the assessment in the same room the

material was located, and of the 3 questions in Part 2, this one did not require outside contact. In less than 8 hours, however, all of the volunteers had obtained verification that the materials were where EGEMS said they were. This means if a researcher were looking to analyze one of these materials, permission could be obtained from the owner to use the material in less than a day's time. A researcher who did not use EGEMS would potentially have had to collect the material themselves, wasting time, energy, and money.

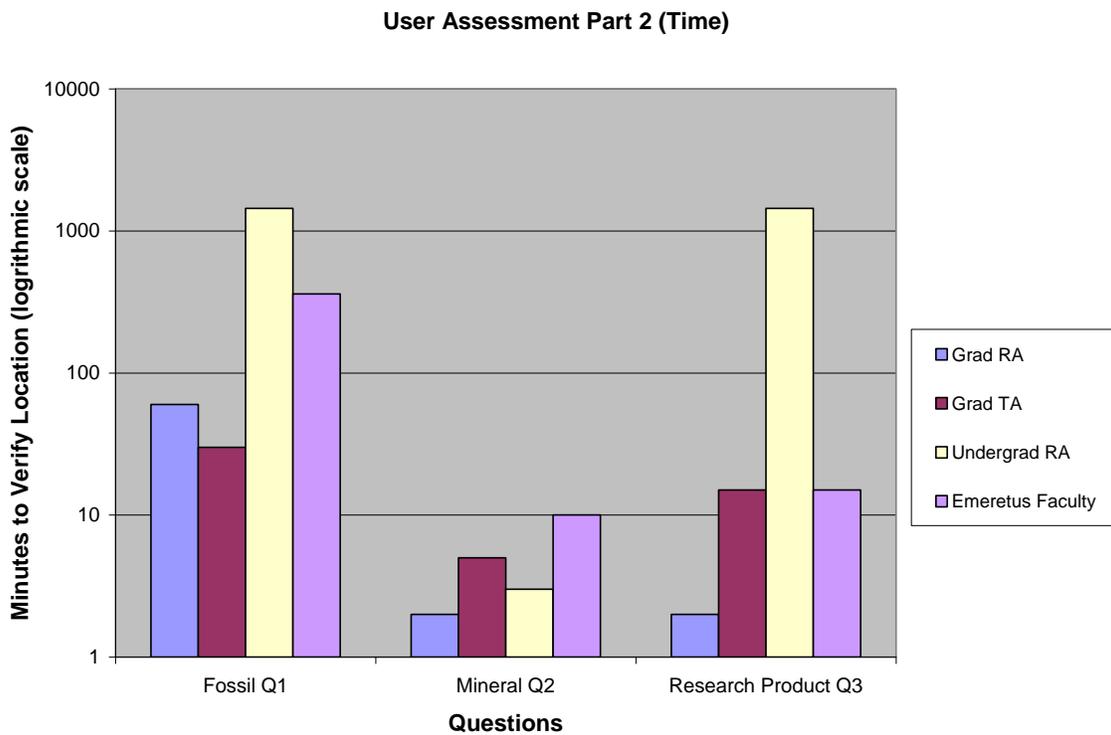


Figure 27. Graph of User Assessment Results for Part 2 illustrating length of time it took for each volunteer to access a specific material.

EGEMS is now fully implemented in the Department of Geosciences at Virginia Tech, which means it is available via network connection to anyone with FileMaker Pro. One laptop has been dedicated as a loaner for anyone who does not have FileMaker Pro to sign out and use for a limited amount of time. In the department it is currently being used by the Museum of

Geosciences as well as by professors, graduate students, and research geologists, and holds over 10,000 records.

EGEMS has been given outstanding reviews by museum professionals from all over the United States as well as Europe and Australia (Appendix D). Many medium to smaller museums have expressed the need for a simple, user-friendly database such as EGEMS. In addition, research institutions are now being mandated by NSF to have a collections policy for materials collected or generated using NSF support. As a result of this demonstrated need, I am developing a business to market EGEMS. EGEMS is a unique and valuable collections management database, which is sure to aid many individuals and institutions in better managing their geological materials.

CHAPTER 3: COMMUNICATION OF GEOLOGIC INFORMATION

Scientific Inquiry

Museums have been educating and inspiring people for centuries, with the oldest surviving museum in America, founded in 1773, being the Charleston Museum in South Carolina (AAM, 2011). Through their exhibits, museums both communicate to visitors the world's most complex scientific ideas and processes and create a comfortable environment for facilitating scientific inquiry.

According to Deborah Perry, a museum consultant from Chicago, a successful exhibit is one that is both fun and educational. Deborah's study on visitors and their interaction with exhibits suggests there are a number of key factors in determining a successful exhibit. She has created a triangle diagram with "Interactions", "Outcomes", and "Needs" as the 3 main categories to convey these factors graphically (Figure 28).

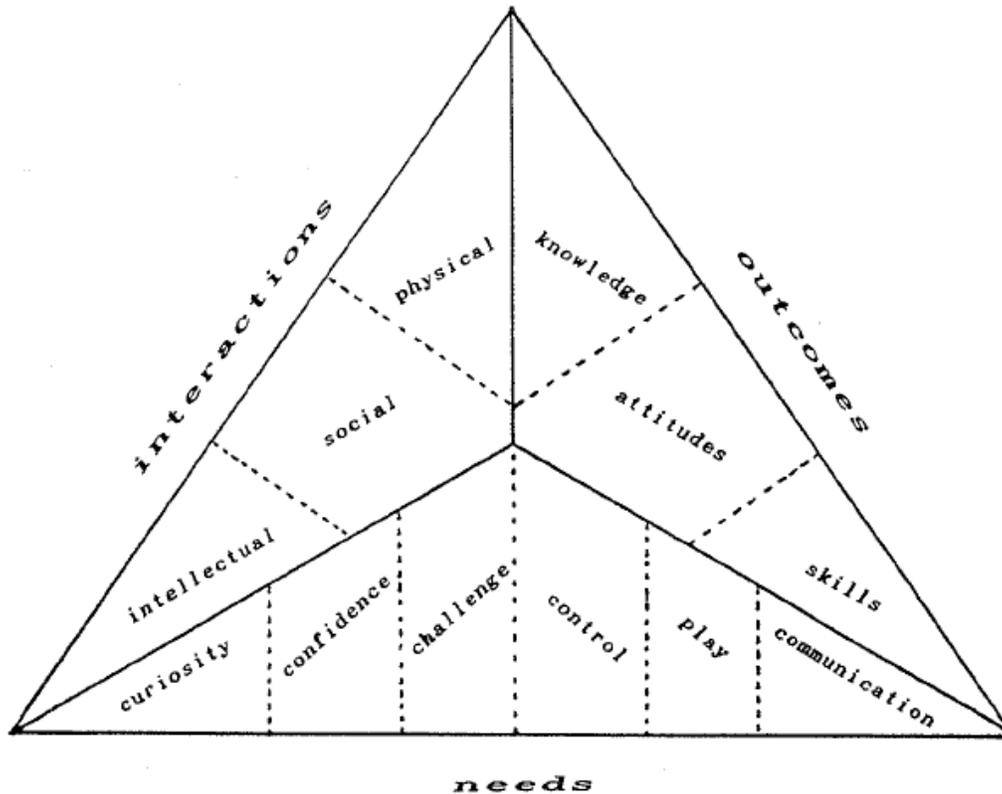


Figure 28. Triangle plot illustrating the key factors in determining the success of a museum exhibit, according to Deborah Perry

Under the category of interactions, she detailed 3 types of visitor participation: physical, social, and intellectual:

All visitors engage physically, even if it is a relatively passive interaction, such as walking through galleries and observing what is going on. Another type of participation is social interaction. Social interaction is often the primary motive for visiting a museum in the first place... Social participation usually includes a certain amount of explaining or teaching behavior, or at least discussing some observed phenomenon... Finally visitors expect and seek some level of intellectual engagement during their visit. They look for opportunities to figure out something, or mentally process new information (Perry, 1993).

Visitor engagement has been studied by many museum professionals in order to understand better what makes a visit successful.

Another factor used to determine the success of an exhibit is the outcome, or how the visitor felt after viewing the exhibit. If the visitor's knowledge, attitude, or skill set was changed, then the visit was more likely to be a success. If the visitor says "It was boring," "I didn't learn anything because I knew it already," etc., then the exhibit was unsuccessful (Perry, 1993).

The visitor's needs are as important as interactions and outcomes. People engage in activities of their own choosing when those activities make them happy. In 1992, one of Perry's studies identified six psychological needs of museum visitors—curiosity, confidence, challenge, control, play, and communication. To meet these needs exhibits must include objects not easily found elsewhere and challenges that are neither so hard that visitors become discouraged, nor so easy that they become bored. The visitor must have fun and interact with the exhibit using multiple senses, and should feel comfortable engaging with the exhibit. When finished, he or she should feel confident in the ability to learn, and want to communicate what they discovered to others (Perry, 1993).

The term "scientific inquiry" is used to sum up the processes involved in learning science. It has no formal definition but "most researchers, practitioners, and learning theorists include such activities as questioning, observing, predicting, experimenting, explaining, synthesizing or applying ideas, arguing with evidence, and communicating ideas to others." (Allen et al., 2009). Scientific inquiry requires the use of higher-order thinking skills and a hands-on, minds-on approach (Wetzel, 2008).

The first science museum to incorporate successful interactive and hands-on exhibits using scientific inquiry was the Exploratorium in San Francisco, California. The museum was founded in 1969 by Frank Oppenheimer as a result of his innovative pedagogical beliefs and practices. In 1957 at a PTA meeting he spoke about these beliefs:

I suppose the first thing I try to do as a teacher is to get my student to understand so clearly some phenomena or device, such as the twinkling of a star...that they realize that understanding, like eating or making a basket during a ball game, is satisfying and fun. If I can succeed in making understanding seem like fun then I believe my student will want to understand many things, that is, he will become curious (Oppenheimer, 1957).

Oppenheimer founded the Exploratorium to give people a chance to learn about science without the pressures of being graded or supervised. His beliefs changed the way museums communicate science to visitors and the way visitors learn about science. A year before the museum was founded, he published an article that discusses the importance of the environment the Exploratorium now embodies:

There is an increasing need to develop public understanding of science and technology. The fruits of science and the products of technology continue to shape the nature of our society and to influence events which have a world-wide significance. Yet the gulf between the daily lives and experience of most people and the complexity of science and technology is widening. There have been many attempts to bridge the gap between the experts and the laymen. The attempts have involved books, magazine articles, television programs and general science courses in schools. But such attempts, although valuable, are at a disadvantage because they lack props... Explaining science and technology without props can resemble an attempt to tell what it is like to swim without ever letting a person near the water (Oppenheimer, 1968).

The pedagogy that revolutionized science museums in the twentieth century is the same pedagogy many educators are trying to incorporate in today's classrooms. This is because students today are struggling to find significance in their education:

If you want to see the significance problem first hand, visit a classroom and pay attention to the questions asked by students. Good questions are the driving force of critical and creative thinking and therefore one of the best indicators of significant learning. Oftentimes the answer to a good question is irrelevant—the question is an insight in itself...Unfortunately, such great questions are rarely asked by students in an educational system facing a crisis of significance. My more common are administrative questions: “How long does this paper need to be? “Is attendance mandatory?” ... “What do we need to know for the test?” Such questions reflect the fact that, for many (students and teachers alike), education has become a relatively meaningless game of grades rather than an important and meaningful exploration of the world in which we live and co-create (Wesch, 2008).

Much like museums before Frank Oppenheimer's time, composed mostly of static uninviting exhibits with facts and answers to questions written in text on the walls, the educational system today is very controlled. Upward of 80 percent of faculty members continue to rely on lecture or a close variation for the majority of their teaching (Meszaros, 2007). This is a serious problem because facts memorized for tests are stored in short-term memory and will not help students solve or even deal with the problems they will face when they graduate and enter the real world. Students need to experiment and problem solve, ask questions, and answer them through trial and error, they need to reflect and learn from their mistakes. In order for students to accomplish this, schools, colleges, and universities need to learn from museums like the Exploratorium and create environments conducive to scientific inquiry. The environments should follow the same factors Deborah Perry suggests are key in making an exhibit successful. They need to be comfortable for students, and the challenges need to be balanced so that they facilitate scientific

inquiry and encourage further learning. The experience should also invoke the use of multiple senses and ultimately be fun and educational at the same time.

Engagement from Behind Glass



Figure 29. Photograph of the exhibit prepared for the 2011 Denver Gem & Mineral Show

Using the knowledge and skills I developed while at Virginia Tech, assisting in the Museum of Geosciences, teaching physical geology labs, and taking courses on pedagogy, I designed an exhibit on behalf of the Museum of Geosciences for the 2011 Denver Gem and Mineral Show (Figure 29). The exhibit is titled “The Search for the Mysterious Mineral” and it uses an interactive detective theme to showcase the research on the Hutter Mine detailed in Chapter 1. The exhibit features manganese rich specimens from the Museum of Geosciences at Virginia Tech, the Virginia Museum of Natural History, as well as my personal collection. It is now on display in the Museum of Geosciences at Virginia Tech.

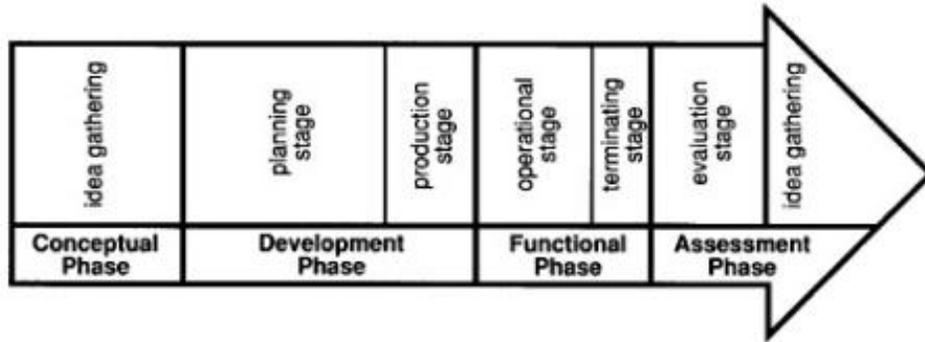


Figure 30: Flow chart illustrating the 4 phases of exhibit design, according to David Dean.

Exhibit design has four primary phases (Figure 30). The earliest is the conceptual phase which includes researching and brainstorming ideas. One of the most important pieces of information to research is audience demographics: this will influence decision making through all of the design phases. Since the Denver show is the second largest of its kind, it was clear that the audience would likely be multi-generational and multi-cultural and the level of geological expertise would probably range from very knowledgeable mineral dealers and natural history museum professionals to novice rock-hounds and young children. In addition, there would be a designated time slot where approximately 1500 students would be visiting the show. As a result of this information my exhibit would need to have a universally catchy theme and could not include too much scientific jargon (Figure 31).

TOPIC	POSSIBLE THEMES	AUDIENCE
Possibility of Rare Mineral "MAN" ($Mn_3SiO_4(OH,F)_2$) at the Hutter Mine In Southern Virginia	<ul style="list-style-type: none"> -Petrology of Manganese Humites -Geosciences Research Equipment -The Scientific Method, What a Geologist and a Detective Have in Common 	<ul style="list-style-type: none"> -Multi-Generational -Multi-Cultural -Variable Geological Expertise

FINAL THEME: The Scientific Method, What a Geologist and a Detective Have in Common

Figure 31. Flow chart for determining the final exhibit theme.

The next challenge, as part of the development phase, was to devise a story that would convey to a varied audience how the scientific method used to research manganese humites from the Hutter Mine, was similar to the process a detective goes through to solve a crime. It is advised, when the audience is diverse, to write all text at the educational level of a typical 15-year-old, so everyone has a chance to understand and appreciate the exhibit (Witteborg, 1981).

One previous study looked at the exhibit design process for 3 exhibits in different museums. In larger museums, exhibits are designed using a team of professionals. One of the core members of this team is the idea generator. An idea generator's job is to develop the main concept for the exhibit, select the content, and formulate the storyline. This study found that idea generators from each museum agreed with the idea that "at the heart of a good museum exhibit is a good story" (Saul Carliner, 2001).

The five essential elements to any mystery are: the characters, the setting, the plot, the problem, and the solution (Penguin Group). For the story in the Hutter Mine exhibit, characters are the

geologists (the people engaging in the exhibit), and the ~~m~~mysterious mineral.” The settings are the Hutter Mine in southern Virginia, chosen for its unusual characteristics and the research reported in Chapter 1, the Rutherford Mines in Central Virginia, and the Sweet Home Mine in Colorado. I chose the Rutherford and Sweet Home Mines for their location and well known, specimen quality. The plot is simple and intriguing. The mysterious ~~m~~“mineral” has yet to be found in nature, but because it has been synthesized in a lab there is a possibility it could be found if it had the right physical and chemical environment in which to grow. The problem is that the conditions for this ~~m~~“mineral” to grow are obviously rare, if they exist anywhere, and in order to find the locality where it would be most likely to be found the geologist (in this case, whoever is interacting with the exhibit) must compare the facts known about the ~~m~~“mineral” to the information for each of the 3 mines. If done systematically, the solution to the mystery (i.e., which mine, if any, this ~~m~~“mineral” would mostly likely be found in) should become obvious, and it is the Hutter Mine. The systematic approach to solving this exhibit’s geological mystery is, in fact, the scientific method.

The first part of the exhibit is designed to entice the audience into completing the steps of this method on their own, engaging them from behind the glass. The second part, although still engaging, is more educational. It illustrates how this same method is used by detectives to solve a crime. It begins with the question ~~W~~“What do a detective and a geologist have in common?” and although the answer ~~T~~“They both follow the scientific method!” is located directly below the question, the hope is that people will realize on their own that they just followed the scientific method when they searched for the ~~m~~“mysterious mineral”. If they don’t make this connection, the following lines say ~~I~~“In the search for the mysterious 'mineral' MAN you were able to experience firsthand the scientific method. The steps in the method are listed below and are used in almost

any problem solving. Can you think of an example when you followed these steps in your life?”

This last question is open-ended and ideally encourages conversation and thought. Finally the principle of juxtaposition was used to compare how a detective and a geologist follow the scientific method (Table 3).

	DETECTIVE	GEOLOGIST
1. Ask a Question	Who committed the crime?	Where might a mineral be found?
2. Do Background Research	Who was in the area of the crime scene and what clues can be found there?	What is known about the mineral and what localities have geologic environments suitable for its growth?
3. Construct a Hypothesis	Arrest prime suspect.	Select localities most suitable.
4. Test your Hypothesis	Question suspect and gather information.	Perform geologic tests and gather data.
5. Analyze Your Data	Perform Analysis of Data.	Perform Analysis of Data.
6. Draw Conclusion and Report Results	Decide whom to charge with the crime, based on the facts.	Decide which locality fits best, based on the data.

Table 3: How a Detective and a Geologist Use the Scientific Method

In addition to selecting a theme and devising the story, the development phase is also when the physical exhibit is designed. This can include many tasks, but for this exhibit it was primarily 1) selecting and obtaining specimens, 2) deciding which stands to use for specimen display, 3) choosing the color and material for the exhibit liner, 4) choosing the color and material for displaying the exhibit text, 5) writing the text, and 6) outlining the space for the exhibit using the

show's guidelines. Early in this phase I used the software application "Paint" to sketch a mockup of the exhibit with spatial dimensions (Figure 32). Sketches and mockups can illuminate problem areas early on.

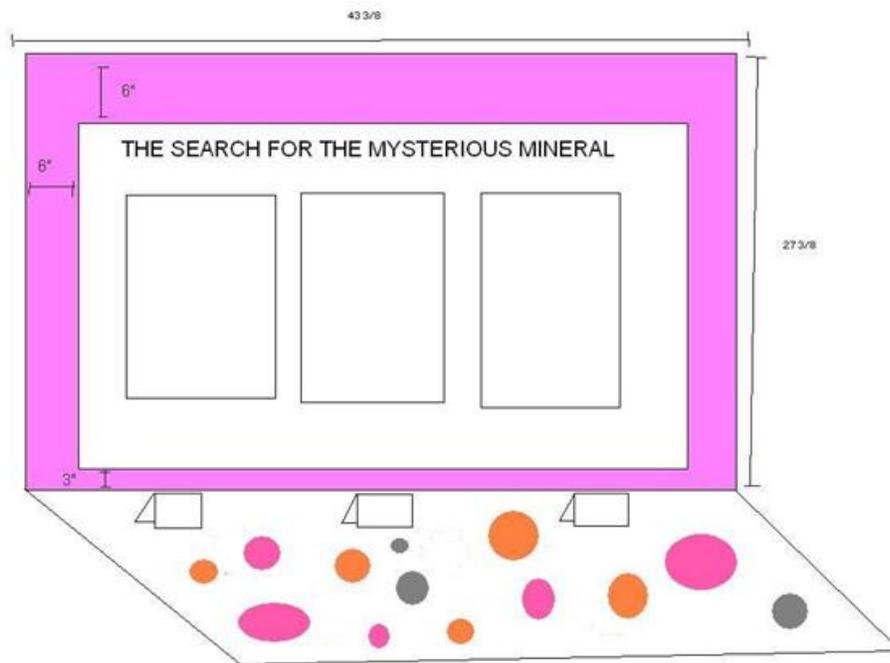


Figure 32: Early mockup of the exhibit illustrating spatial dimensions.

Choosing which minerals to use was fairly simple after the decision had been made to use the three mines noted above. EGEMS, the database described in detail in Chapter 2, was employed to search for notable manganese minerals from the 3 localities; the Museum of Geosciences has many spessartine-rich garnets from Virginia, as well as rhodochrosites from Colorado. In addition I searched for unique manganese minerals from around the world, even deciding to use a banded rhodochrosite from my own collection. From the many specimens available, ones that exhibited different crystal forms were selected. This included cut gemstones which brought a sparkle to the exhibit under the bright lights.

The exhibit theme and design also required use of Hutter Mine specimens from the Virginia Museum of Natural History. Three appropriate specimens were obtained through a visit to VMNH and a specimen loan, but they were quite large and not nearly as nice in quality as the rest of the specimens that had already been chosen. With permission, two of them were cut (the third sample was already small enough and had a previously cut side), and all of them were polished to produce attractive surfaces that showed off the textural detail. This worked well and visitors at the show expressed compliments on the interesting contrast they provided in the exhibit.

The cases used in the Denver Show are solid wood on all sides, except the display front which has a glass window. The window, however, is not centered in the front, but is shifted slightly down and there is a wooden frame around the window on the outside. The black circle in Figure 33 shows approximately the same location on all photos. In 33a there is no cover on the case, whereas in 33b there is. If the space at the top had not been planned for, the exhibit might have had text that was not visible to most adults. The tape in 33c outlines where it was probable that the text would be visible.

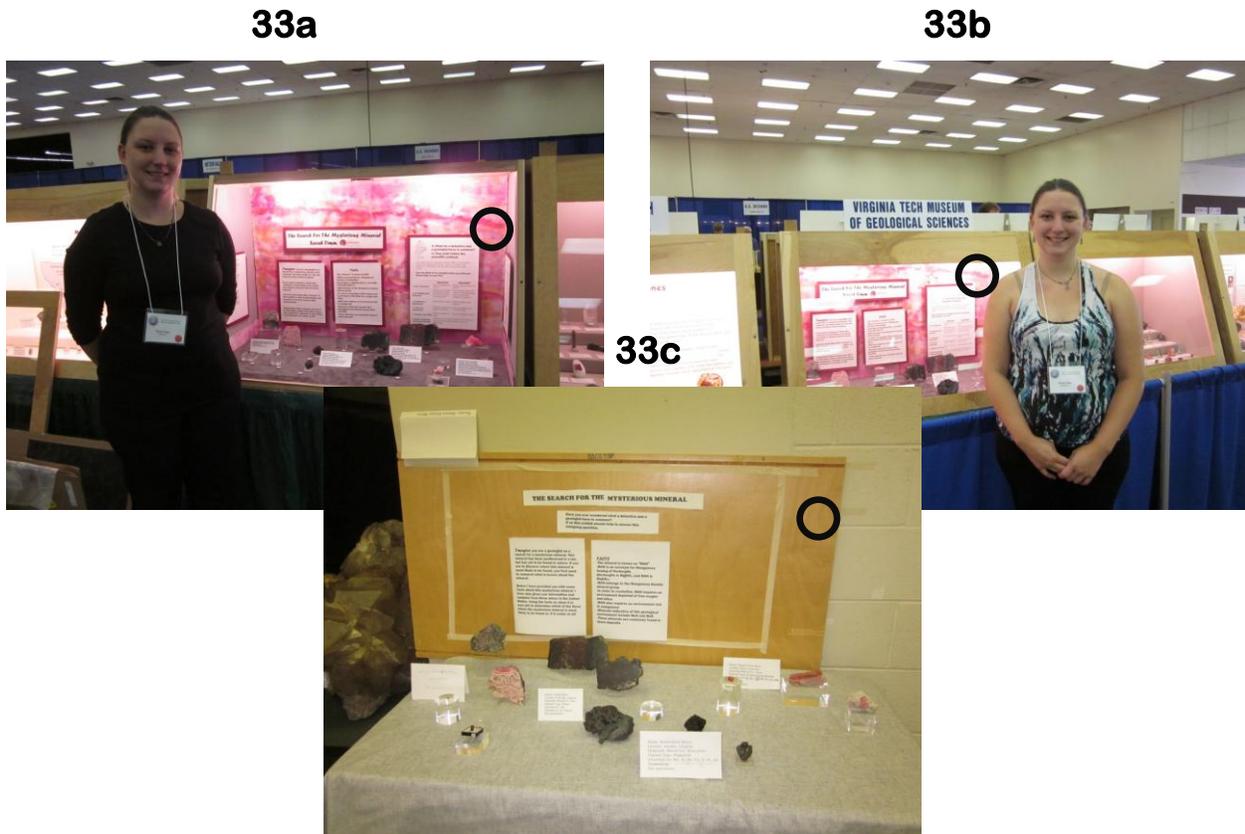


Figure 33: Photographs of the exhibit taken at different times and illustrating the importance of preparing the exhibit layout to scale.

Labels and typography are another important part of exhibit design. According to the book –“Good Show” (a guide for temporary exhibits), sloppy typography is the mark of an amateur.

This book is provided much information and guidance as the exhibit was developed, such as this label writing checklist:

1. Is the story line of the exhibit accurately and concisely formulated?
2. Does the text reflect the vocabulary and assumed knowledge of the target audience?
3. Are labels worded with a view to clarity?
4. Are labels overloaded with information?
5. Are there any superfluous labels? (Witteborg, 1981)

Colleagues, friends, and a few museum professionals asked during the prep work for the exhibit, and after the show, why the decision was made to letter the specimens and post the label information on the side of the exhibit. This was done for two reasons. The first is that there would be a varied and diverse audience at the show, some of whom were much more interested in the esthetic view of the specimens than in reading the scientific details on the labels. In addition, there already were 4 pieces of text on the base of the exhibit and having a separate label for each of the specimens would likely clutter the space and make some smaller specimens less visible. For the whole exhibit only four complementary fonts were used, mostly sans-serif, to lessen any discomfort in reading. The most eye-catching font was used for the title and first words, to abide by the 3-30-3 rule used not only in exhibits but in whitepapers and websites as well: 3 seconds to hook your audience, 30 seconds to reel them in, and 3 minutes to hold their attention. To aid with this I chose comical clipart and used a very pink background, echoing the pink color of many of the Mn-rich specimens. At the show it was much easier for someone to remember of this exhibit ~~it~~ “s the really pink one” than either the exhibit number or name.

Selection of the liner for the case took much longer than expected, but ended up being worth the time. It began by researching what materials are best for liners. A lot of mixed advice was given, such as ~~use~~ “use material like felt so you can easily roll it to ship” “don’t use material that can bunch up or have wrinkles” etc. On one of many visits to Michael’s craft store, the decision was made to use matboard because it wouldn’t wrinkle or bunch in my exhibit and it had a clean professional look. After trying out differently colored matboard with fake colored gems from the store, it became clear that the light gray matboard on the sides and the dark gray matboard with the mottled suede texture on the bottom looked the best. However, matboard is expensive and

due to the awkward dimensions of the case, it would be a special order item. After some calculations the framing department helped me figure out the smallest amount of matboard stock that was needed. When it came time to pick it up at the end of the week, it turned out the matboard had been damaged during the shipping process. This in turn led to extra matboard but since the case ended up being larger than expected I was able to improvise.

Early in the design process it was decided to collaborate with artist Susan Eriksson, retired curator of the Museum of Geosciences at Virginia Tech. She agreed to paint a background for the exhibit symbolizing the uniqueness of banded rhodochrosite (Figure 34).

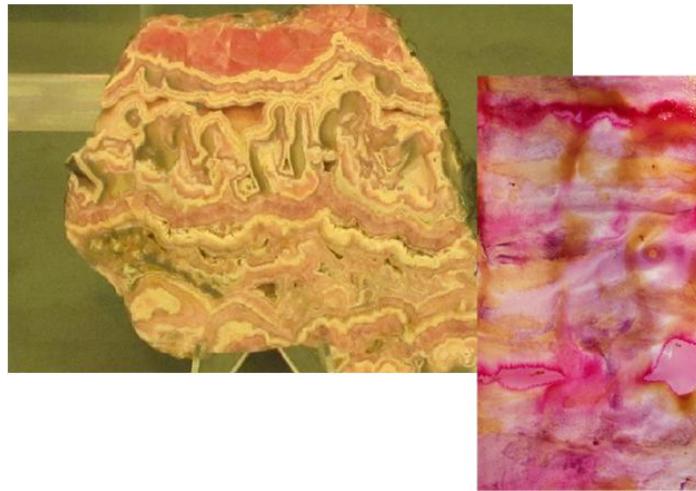


Figure 34. A close-up of Susan Eriksson's painting (in the front) representing the Banded Rhodochrosite (in the back).

The last part of the development phase was to arrange all of the different pieces to create the final exhibit design. For the mineral specimens this was not really a problem, but for the text it took some creativity because the exhibit was not going to be officially put together until all of the pieces were shipped to Denver. Since the paper needed to be held up on the matboard without using adhesive, magnets and paperclips were employed (Figure 35). Also, until the last weeks

before the show stand-in gems and minerals were used for some of the specimens because they were on display in the museum, and not easily obtainable.



Figure 35. Photograph of exhibit preparation illustrating the use of magnets to preview the exhibit text.

The minerals were arranged according to their original mine location. This split the bottom of the exhibit nicely into four equal sections (Figure 36). For the text on the walls, white cardstock bordered by maroon cardstock was used to balance with the colors of the artwork and most of the minerals. Thick foam core was used to raise the text on the back but since it would be seen on the sides by viewers, thinner foam core was used there. After everything was ready to go, the exhibit was disassembled and an inventory list with photos was made for security purposes. The final step in the development phase was to ship the exhibit to Denver. Though there were numerous complications with shipping, they were overcome, and the boxes were retrieved when safely in Denver.



Figure 36. Photographs of the exhibit specimens organized by locality, each with an informational label.

The functional phase began with the start of the show, and with 1500 school children. It continued throughout the weekend and on the last day of the show the Society of Mineral Museum Professionals held their annual program, “Meet the Curator.” Since the Denver show attracts numerous people, major museums display exhibits that bring many museum professionals together at one time. As a result the Society of Mineral Museum Professionals (SMMP) holds their annual meeting at the show.

For one hour during the show, the SMMP had a representative from each museum stand by his or her display case so the general public could ask questions. In the past there had been less interest in this program on the last day, so since I had leftover pieces from mineral collecting the day before, I brought them to the exhibit, and offered free specimens to children and adults. This spurred conversations about the visitor’s interest in geology and most took the time to look at the exhibit, some while their children were preoccupied with the free samples.

Free samples or not, the number of people who stopped by was amazing: in just one hour approximately 50 people of all ages stopped and conversed. A few people even stopped by specifically to ask a question prompted by viewing the exhibit previously. The exhibit was designed to be interactive and educational, and over the course of this hour it became clear this goal had been met. Figure 37 shows photos of many different people engaging with the exhibit. In the first picture, 37a, the two boys are brothers and their mother had asked that they be walked through the exhibit. I told them about the “mysterious mineral” and showed them how to use the facts as clues to discover which mine it might be found in. The younger brother just started guessing, but the older brother picked up on the process and then showed his brother how to look at the facts about the “mineral” and compare them to the facts about the mines. It was clear from this interaction that the exhibit enabled scientific inquiry. The children in 37b though they were a bit younger, also interacted with the exhibit.. Though they did not come to the correct conclusion they did use scientific inquiry, and I explained to them what the right answer was and why. Their parents were standing behind the children and afterwards the children turned to them and relayed their new knowledge. In 37c the exhibit prompted a conversation between two unrelated people. As mentioned in the first section of this chapter, a successful exhibit stimulates communication. Lastly, in 37d, the mother knew a bit about geology and used my exhibit to relay this knowledge to her daughter. She appreciated that the scientific method had been included. As a teacher herself, she told me of her constant surprise that her students aren’t more familiar with the method, since it is a fundamental concept in the earth sciences.



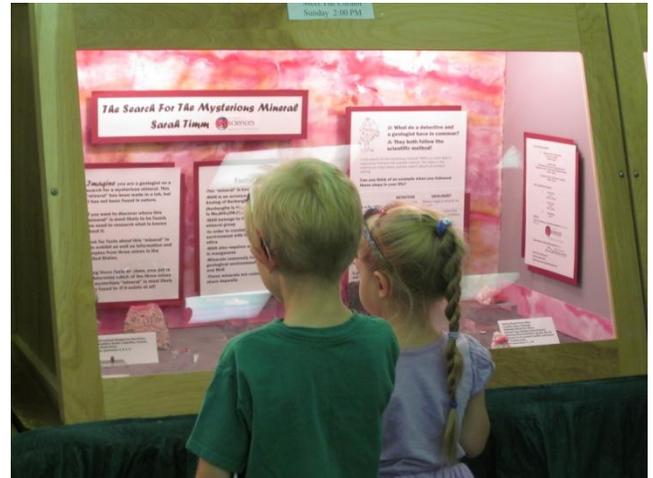
37a



37b



37c



37d

Figure 37. Various audiences engaging with the exhibit, and regardless of age or gender, everyone seemed interested in it.

The assessment phase for the exhibit is still ongoing. Lots of feedback was received in Denver when the exhibit was displayed there, and now that the exhibit is set up in the Museum of Geosciences feedback is still coming in. This project taught the best and worst practices of designing a successful exhibit, as well as how much time and effort goes into building even a small display. With this knowledge and first-hand experience, a new appreciation for museums and their exhibits has been gained.

REFERENCES

- Allen, S., & Gutwill, J. *Creating a program to deepen family inquiry at interactive science exhibits*. Curator: The Museum Journal. (Vol. 52.3) 289-306. 2009
- American Association of Museums (AAM). *The Accreditation Commission's Expectations Regarding Collections Stewardship* [http://www.aam-us.org/museumresources/accred/upload/CollectionsStewardshipACE\(2005\).pdf](http://www.aam-us.org/museumresources/accred/upload/CollectionsStewardshipACE(2005).pdf)
- American Association of Museums (AAM). *A Snapshot of American Museums*. http://www.aam-us.org/am11/upload/AAM-2011-press-kit-Financial_Snapshot_of_Museums_-2011_ed-Final.pdf
- Beard, James S. and Tracy, Robert J. *Spinels and other oxides in Mn-rich rocks from the Hutter Mine, Pittsylvania County, Virginia, U.S.A.: Implications for micibility and solvus relations among jacobsite, galaxite, and magnetite*. American Mineralogist, (Vol. 87) 690-698. 2002
- Chenhall, Robert G. *Museum Cataloging in the Computer Age*. Nashville: Tenn., 1975
- Dean, David. *Museum Exhibition: Theory and Practice*. London: Routledge, 1996
- Francis, Carl A. and Ribbe, Paul H. *Crystal structures of the humite minerals: V. Magnesian manghanumite*. American Mineralogist. (Vol. 63) 874-877. 1987
- Friedrich, Otto. "The Computer Moves In." Comp. Michael Moritz/San Francisco, J. Madeleine Nash/Chicago, and Peter Stoler/New York. *Time Magazine* Otto Friedrich. Reported by Michael Moritz/San Francisco, J. Madeleine Nash/Chicago and Peter Stoler/New York 03 Jan. 1983
- Huebner, Stephen J., Flohr, Marta J. K., and Grossman, Jeffrey N. *Chemical fluxes and origin of a manganese carbonate-oxide-silicate deposit in bedded chert*. Chemical Geology, (Vol. 100) 93-118. 1992
- Meszaros, Peggy S. *Self-authorship: Advancing Students' Intellectual Growth*. San Francisco, CA: Jossey-Bass. 2007
- Oppenheimer, Frank. *Teaching and Learning*. Address. Pagosa Springs High School PTA Meeting. Pagosa Springs, Colorado. 1957. Exploratorium.
- Oppenheimer, Frank. *Rationale For A Science Museum*. Curator: The Museum Journal. (Vol. 1.3) 206-09. 1968. Exploratorium.
- Penguin Group. "The Five Essential Elements of a Mystery." <http://us.penguin.com/static/packages/us/yreaders/camjansen/CamDownloadables/FiveEssentialElementsofaMystery.pdf>
- Perry, D. L. *Beyond cognition and affect: The anatomy of a museum exhibit*. In D. Thompson, S. Bitgood, A. Benefield, H. Shettel, & R. Williams (Eds.), *Visitor*

- studies: Theory, research and practice.* (Vol. 6, pp. 43-47). Jacksonville, AL: Center for Social Design. 1993
- Pouchou, J.L. and Pichoir, F. "PAP" procedure for improved quantitative microanalysis. *Microbeam Analysis.* 104-105
- Sarasan, Lenore, and A. Michael. Neuner. *Museum Collections and Computers: Report of an ASC Survey.* Lawrence, Kan., U.S.A.: Association of Systematics Collections, 1983
- Saul, Carliner. *Modeling Information for Three-dimensional Space: Lessons Learned from Museum Exhibit Design.* Technical Communications. (Vol. 48.1) 66-81. 2001
- Tracy, Robert J. and Beard, James S. *Manganoan kinoshitalite in Mn-rich marble and skarn from Virginia.* *American Mineralogist* (Vol. 88) 740-747. 2003
- Tracy, Robert J., Henika, William S., and Beard, James S. *Minerals of the Hutter Mine A New Manganese-Barium Mineral Locality in Northern Pittsylvania County, Virginia.* *Rocks & Minerals,* (Vol. 77) 320-325. 2002
- "US NSF - About." *Nsf.gov - National Science Foundation - US National Science Foundation (NSF).* 2011 <<http://www.nsf.gov/bfa/dias/policy/dmp.jsp>>.
- Weimer, Maryellen. *Learner-centered Teaching: Five Key Changes to Practice.* San Francisco: Jossey-Bass, 2002.
- Wetzel, David. *What Is Scientific Inquiry.* Ezine Articles. 5 June 2008
- Wesch, Michael. *Anti-Teaching: Confronting the Crisis of Significance.* *Education Canada.* (Vol 48) 2008
- White, T.J. and Hyde, B. G. *Electron Microscope Study of the Humite Minerals: II. Mn-Rich Specimens.* *Physics and Chemistry of Minerals* (Vol. 8) 167-174. 1982
- Winter, G. A. Mn-humites from Bald Knob, North Carolina: mineralogy and phase equilibria. *American Mineralogist.* (Vol. 68) 951-159. 1983
- Witteborg, Lothar P., and Andrea Stevens. *Good Show! A Practical Guide for Temporary Exhibitions.* Washington, D.C.: Smithsonian Institution Traveling Exhibition Service, 1981

APPENDIX A
NEEDS ASSESSMENT

Needs Assessment for Masters Thesis Project

For my masters thesis I am designing E-GeMS, the beta version of an electronic geological management system. E-GeMS will directly benefit the Department of Geosciences at Virginia Tech in that it will create potential accessibility to all of the department's geologic materials, including materials synthesized in the lab.

These are the fields I am currently using in the database to record information about the research product collection. Research products include: polished thin sections, billets, experimental samples prepared for use on various analytical equipment, etc.

Please take a few minutes to answer these questions, they will contribute greatly to the design of E-GeMS.

1. Please select the fields that would be useful to you in referencing research materials. If a field you would use is not listed please see question #2 at the bottom of the page.

	useful	not useful
ID # (catalog number)	<input type="radio"/>	<input type="radio"/>
Label (For example, slide HM-20)	<input type="radio"/>	<input type="radio"/>
Alternative Label	<input type="radio"/>	<input type="radio"/>
Owner (For example, VT Dept of Geosciences)	<input type="radio"/>	<input type="radio"/>
Current Location General	<input type="radio"/>	<input type="radio"/>
Current Location Specific	<input type="radio"/>	<input type="radio"/>
Date Research material Last Accounted For	<input type="radio"/>	<input type="radio"/>
Who Last Handled Material	<input type="radio"/>	<input type="radio"/>
Provenance (For example, sent from XMNH by	<input type="radio"/>	<input type="radio"/>

	useful	not useful
Mary Jane in January 2011)		
Creator	<input type="radio"/>	<input type="radio"/>
Creation Process (For example, cut from rock specimen ID# 21 using rock saw from XMNH)	<input type="radio"/>	<input type="radio"/>
Date Research Material Created	<input type="radio"/>	
Type (billet, slide, etc)	<input type="radio"/>	<input type="radio"/>
Description	<input type="radio"/>	<input type="radio"/>
If Hazardous and Why		<input type="radio"/>
Distinguishing Characteristics (For example, bright red and extremely rare)	<input type="radio"/>	<input type="radio"/>
Weight	<input type="radio"/>	<input type="radio"/>
Size	<input type="radio"/>	
Bibliographic Citation	<input type="radio"/>	<input type="radio"/>
Is Part of (For example collection ID #001)	<input type="radio"/>	<input type="radio"/>
Image	<input type="radio"/>	<input type="radio"/>
Present Value (\$)	<input type="radio"/>	<input type="radio"/>
Composition and/or Formula	<input type="radio"/>	<input type="radio"/>
Date Record Created	<input type="radio"/>	<input type="radio"/>

2. If a field(s) you would utilize is not listed in question 1, please list it here.

3. If you know of any geological materials, besides the ones listed below, that you think should be incorporated into this database please give a brief description of what they are and where they are currently located.

- Ground floor of Derring Hall/ Wavetank room: oversized specimens and teaching collections
- Second floor storage cabinets: petrological collection
- Third floor storage: metamorphic and sedimentary rock collections
- Fifth floor 5056: maps with corresponding rock samples and thin section teaching collection
- Throughout Derring Hall: Museum of Geoscience collections

4. Do you feel E-GeMS will benefit you, and if so, how?

5. If you have any questions, comments, or concerns, please provide them in the space below. I will do my best to address them!

APPENDIX B
PROGRESS LOG

Person/People I Met With	Highlights of Discussion/Notes	Hrs Work	Date	Pg	How Corresponeded
Committee	Came up with idea for Collections Project		1/12/11		In Person & Conference Call
	Took inventory of the 2 nd floor petrology collection, ~6,000 materials. Also looked at materials in 5056 with Bob		1/19/11	3	
	Went to the library and researched about museum collections/cataloging and computers. Took out 2 books on the topic and copied chapter from Museum Registration Methods 3 rd Edition.		2/10/11		
	Wrote the first part of the proposal (At this point writing for IMLS grant.)		2/12/11		
Dr. Ed Fox	Discussed the importance of knowing who is involved and what they need most. Took a "step back" from figuring out how to implement the project. He provided 2 books for me to read, one on Digital Libs very good!		2/14/11		In Person
Maddy Schreiber	Discussed funding from the department, specifically regarding the summer		2/14/11		In Person
Llyn Sharp	Mentioned about student loans and Community Foundation of NRV grant		2/15/11		In Person
Nancy Ross	Informed me on synthetic materials		2/15/11		E-mail
EMU	E-mailed to see if wanted to collaborate, or give advice		2/15/11		E-mail
	Created questions for Needs Assessment		2/15/11		
Llyn Sharp	Discussed how this database could benefit museums if implemented		2/17/11		In Person and E-mail
James Dale	Talked about my project and he suggested looking into Quartzzy, a freeware database for chemical reagents		2/20/11		In Person
Danielle Skurka	Discussed grants, specifically CFNRV grant as she is taking a granting class and a woman from the foundation came and spoke to them on how the grant needs to benefit the community and have clear funding needs (not just		2/20/11		In Person

	summer living expenses).				
Ed Fox	E-mailed Needs Assessment questions for review and also asked if could give me contact info on who to talk to about hiring a CS student. He immediately replied and forwarded my query to others, see below		2/20/11		
	Created Need Assessment Survey based on questions I came up with earlier		2/20/11		
Cal Ribbens & Ginger Clayton	Replied to Ed's e-mail and said that it depends but if was paying a student \$10 or \$15 per hour it would depend on the amount of time. Ie \$10 for 50 hours =\$500		2/21/11		E-mail
Richard Timm	Discussed scope of project and reality. Decided that needed to better define and separate where my masters thesis is completed and where a much larger cost/time intensive project with a commercial product begins		2/21/11		Call
	Had 3 profs and 2 grads look over survey and provide feedback		2/21/11		
Bob Tracy	Had discussion on scope of project (spurred on by discussion above) also discussed funding for summer and funding for CS student. Bob said he would speak with Llyn regarding both and get back to me.		2/21/11		In Person
	Wrote the phases of my project design for the proposal		2/21/11		
Jayant Kulkarni	E-mailed Quartzzy to see if anyone these could provide information on their "story", discussion on design struggles choices etc. Heard back from Jayant and set phone call for Friday 10am				E-mail
Jonathan Leidig	Extensive discussion on databases, data models, digital libraries and other terminology. He showed me how to create the database and code needed to send to a CS student. Was able to create a pretty solid timeline after this meeting.		2/22/11	7-9	In Person
Jayant Kulkarni	Phone conversation about his work with Quartzzy		2/25/11		Call

Llyn Sharp	Meeting with Llyn, discussion on FileMaker vs Access and trip to Prices Fork storage facility		3/1/11	13-17	In Person
	Wrote grants for CFNRV and Dept's Summer Internship in the Museum and Dept Summer Stipend		Spring Break		
Kurt Christiansen	Met with Kurt and learned a lot about databases and the various pieces. He showed me a lot of HTML and MySQL, especially the MySQL Workbench		3/11/11	21-26	In Person
Bob Tracy and Llyn Sharp	Met with Bob and Llyn, start of Bi-weekly meetings to eliminate miscommunication Went over grants and discussed MySQL Workbench and My SQL as the platform to use (Had it installed that day)		3/14/11		In Person
	Handed in CFNRV grant proposal		3/16/11		
Richard Godbee	Met with Richard Godbee, our Department's IT specialist in MySQL I wanted to know if he thought MySQL, Access, or FileMaker would be best for my thesis and he said FileMaker because it's all in one and runs on mac and pc, so I decided to go with that. It turns out MySQL Workbench can still be used to model table relationships		3/17/11		In Person
	Finished Dept grant for Summer stipend (Denver exhibit) and research (travel to Denver)		3/18/11		
Gary Worley	Met with Gary to discuss the Discovery Commons Project which Llyn thought might be useful. It turns out it could be a good future for my thesis project but it won't matter much now as it is a repository of VT databases. This is useful because FileMaker only allows 5 people on the server at a time and Discovery Commons is unlimited access for anyone. Found out at this meeting about FDI courses and that a Microsoft Access one was being offered soon.		3/18/11		In Person
Jean Lacoste	Took class 1/5 of the Microsoft Access database design course. VERY helpful as Jean started from the way basics.		3/22/11	29-30	In Person/Class (Notes on Access are in Livescribe)

	Learned all about normalization and a lot of my previous confusion became clear.				
Committee	Reviewed and had approved annual report, plan of study, and thesis prospectus (see meeting 3 notes for more details)		3/24/11	31	In Person
	Researched and learned about Dublin Core. Started real work on E-GeMS, made sample report and wrote out all the attributes from it (using Dublin Core) then grouped them and assigned primary keys. Stopped before normalization, e-mailed Jean about meeting to get help with that		3/27/11		
Jean Lacoste	Took Microsoft Access Class 2/5 learned about creating the tables and fields and the relationships and tricks for doing so		4/5/11		In Person (Notes on Access are in Livescribe)
Bob Tracy and Llyn Sharp	Progress Meeting, showed my progress in excel and the work I did on 3/27 discussed needs assessment and filemaker liscence, decided to put it on a developmental laptop from MoGs		4/6/11		In Person
Llyn Sharp	Obtained developmental laptop and also spent time with Llyn on superbase		4/7/11		In Person
	Spent time with the official FileMaker Pro (not the trial version) Designed tables and fields and learned a lot about how it works, got stuck with one relationship not working		4/11/11		
Richard Godbee	Met with Richard regarding the problem with my FileMaker relationship, figured it out and learned more about the software		4/11/11		In Person
Jean Lacoste	Took Microsoft Access Class 3/5 learned about creating Forms in Microsoft Access in order to keep data input easy and neat		4/12/11		In Person (Notes on Access are in Livescribe)
	Sent thank you e-mail to consultants		4/15/11		
	Worked on the layout for FileMaker used for searching and inputting data, similar to forms in Access, got stuck on portals but everything else turned out great!		4/17/11	35	
Richard	Met with Richard and fixed the		4/18/11		In Person

Godbee	problem with my portals and well as spiffed up some other things.				
Adam Mansur and Leslie Hale	E-mailed Adam to find out if he was available this summer to assist me with Emu at the NMNH (received confirmation soon after, and was in touch with Leslie Hale at this time as well)		4/18/11		E-mail
Jean Lacoste	Took Microsoft Access Class 4/5 learned about creating queries in Access which is the same as "ifds" in FileMaker. Got E-GeMS published to the web!!!		4/19/11		In Person (Notes on Access are in Livescribe)
Bob Tracy and Llyn Sharp	Meeting with Bob and Llyn, discussed the issue of catalog numbers labels titles and other issues with what fields to include and how to name them in the layout. Also added a few (size and type) and discussed these. Also talked about needing to figure out how to do loans, and auto-history as well and play with security. Touched on summer internship and needs assessment.		4/21/11		In Person
Kay Johnson	E-mailed Kay Johnson to set up a meeting, she knows a lot about Libraries and archiving		4/24/11		E-mail
	Read up on the security for filemaker		4/25/11		
Keri Swabi	Met with Keri, a woman I met at the Access class, to share what I learned already and help her with her filemaker project		4/26/11		In Person
Ed Fox	Met with Ed Fox, discussed his digital libraries class in the fall as well as the JCDL conference paper and user studies		4/26/11	39	In Person
Jean Lacoste	Took Microsoft Access class 5/5 which was importing/exporting and reports		4/26/11	41	In Person (Notes on Access are in Livescribe)
	Needs Assessment send out on grad student list serve and faculty list serve also sent personal follow-up to certain research geologists		4/26/11		
Kay Johnson and Llyn Sharp	Met with Kay and Llyn and discussed various librarians at VT who may be helpful to me as well as the GSIS		4/29/11	42-43	In Person

	society she is a member/leader in also lib of congress and visit to DC				
Llyn Sharp	Llyn Showed me more about super base, made me think what might be useful in E-GeMS		4/29/11	44-45	In Person
Richard Godbee	Help with instant web publishing issue, assessing on other computers				In Person
	Learned basic scripting, discovered issue with super audit scripting and created tree diagram of E-GeMS		5/1/11		
Gail McMillian, Aaron Pucell, Ed Lener, and Philip Young	Sent e-mails to all librarians Kay mentioned to set up meetings and heard back from Ed		5/1/11		E-mail
	Sent help message to filmmaker pro regarding the issues above		5/2/11		E-mail
	Downloaded trial version of Past Perfect		5/2/11		
Bob Tracy and Llyn Sharp	Meeting with Bob and Llyn, discussed summer timeline. Goal is that when I get back from DC I have a filmmaker pro file ready to go for a student to do data input. We got the CFNRV grant for \$500! Also discussed success of Needs Assessment (16 responses at this time) and possibility of a re-send for more responses.		5/4/11	47	In Person
Llyn Sharp	Afternoon with Llyn, discussed Denver exhibit and the strategy and time management of that project this summer		5/4/11	48	In Person
	Heard back from woman at Lib of Congress and set up a meeting with her. Also heard back from Philip Young and Aaron Purcell (setting up meeting with Aaron for later in the summer if needed)		5/4/11		E-mail
Eric Christensen	Spent the evening trying to write a code to make a history log, got close but have issue with creating new records. Will meet with Richard on Friday to discuss.		5/4/11		In Person
Philip Young	Had meeting in Library, discussed authority files and suggestions for E-GeMS		5/6/11	49	In Person (Notes are also in Livescribe)

Richard Godbee	Even with Richard's help (and the filemaker pro forum) the issue with the E-GeMS history and creating new records is not solved. Maybe need to find someone who knows filemaker better?				
Ed Lener	Had meeting in the Library, discussed design on E-GeMS with respect to the user. Talked about how library's catalogue and query and what I can do to improve E-GeMS. He also emphasized Gail would be good to meet with. We also talked about copy write and he suggested I contact Annette Baily who write firefox extensions but works at VT, or just contact the VT dept of intellectual properties.			50	In Person (Notes are also in Livescribe)
	Hit my goal of 25 responses on the needs assessment after re-send!!		5/8/11		
	Visit to DC		5/9/11-5/12/11		
Jonathan Leidig	Met with Jonathon to try and resolve change history issue with no success		5/13/11		In Person
	Met with Bob and Llyn		5/26/11		
	(Begin keeping track of approximately how many hours of work I am putting into E-GeMS)				(Stopped keeping track on how I contacted the person since from here on out was mostly in person unless otherwise noted.)
	Worked on E-GeMS	4	5/25/11		
	Worked on E-GeMS	16	5/26/11-5/31/11		
Richard Godbee	Worked on E-GeMS Met with Richard. Met with Bob and Llyn.	4	6/1/11		
	Worked on E-GeMS Met with Bob about teaching specimens.	8	6/2/11		
	Worked on E-GeMS Met with Richard	6	6/3/11		
	Worked on E-GeMS	~4	6/6/11		
Neil Johnson	Worked on E-GeMS Met with Neil Johnson in regards to his thoughts on E-GeMS. He proposed we use his collections to trouble shoot research products. Scheduled to begin mid-July.	8	6/7/11		

	Worked on E-GeMS, long day working with the minerals. First day using officially using E-GeMS! James brought down a box from Mike Hochella's office. James said Mike was cleaning his office and though he to "tossed a bunch of stuff" he thought the things in this box the museum might want. Well it turns out that there was a specimen in this box of specimens that actually came from the museum. We used E-GeMS to put it back where it was supposed to be. I have photos of the specimen.	~7	6/8/11		
	Worked on E-GeMS, long day working with the minerals, got it to the same organization and presentation as rocks and research products.	8+	6/9/11		
	Showed Parents E-GeMS and worked with Dad for a bit on the loans issue.	1	6/11/11		
Richard Godbee	Worked on E-GeMS Met with Richard.	~5	6/13/11		
Troy & Jackie	Worked on E-GeMS. Also met with Troy and Jackie regarding fossils.	7	6/14/11		
Lindsay	Worked on E-GeMS. Also met with Lindsay regarding minerals on the 3 rd floor, and Kristie regarding 5056 stuff.	5	6/15/11		
Richard Godbee & Anna Hardy	Worked on E-GeMS. Met with Richard. First day inputting NEW data into E-GeMS, working with Anna Hardy (museum assistant using CFNRV grant \$). Fixed Loans (mostly)	8+	6/16/11		
	Worked on E-GeMS. E-mailed V-TIP (intellectual properties) Also Eric, using his own copy, trouble shooted all the fields with me for minerals, finding many authority files missing and ways to input data where you shouldn't be able to.	6	6/17/11		
	Eric trouble shooted rocks and research products too, and I fixed all the issues.	3+	6/18/11		
	Worked on E-GeMS a lot. Worked on print screen shots and created an E-GeMS e-mail account.	~9	6/20/11		

	Worked on E-GeMS. Helped Anna to input 13 more NEW minerals into E-GeMS.	6+	6/21/11		
	Worked on E-GeMS. Created the relationships for and designed the documents layouts and fixed some other things.	4	6/22/11		
Bill Henika	Worked with Bill Henika, taught him how to use E-GeMS. He input 2 full screen records for rocks he is using in a gravity study. Also helped Anna to enter 1 more entry. She in now cleared to enter data whenever she is working, or would like to.	6	6/23/11		
	Bill worked on his own to enter 1 more entry. He is now cleared to enter data whenever he has time and the MoGs computer is free. Met with Richard, officially fixed loans! Also created the relationships for the E-GeMS address book.	6	6/24/11		
	Worked on E-GeMS. Created the layout for the address book. Updated this progress log. Entered Superbase > FileMaker Import sheet Notes into excel.		6/25/11		
	Feedback from family members on E-GeMS	2.5	7/1-7/6/11		
	Worked on E-GeMS, mostly incorporating family's comments	4	7/8/11	90	
	Worked on E-GeMS help screens which ended up not being needed	2	7/9/11		
	Worked on E-GeMS help screens which ended up not being needed	2.5	7/10/11		
Steve Lockett	Meeting with Steve Lockett from VTIP	3+	7/11/11	92	
Neil Johnson	First meeting with Neil Johnson to Trouble Shoot E-GeMS Research Products	3	7/12/11	93	
Jim Beard & Butch	Trip to VMNH, showed Jim Beard and Butch (Alton) the Database, they seemed impressed and provided good feedback		7/13/11	95	
	Worked on E-GeMS	2?	7/14		
	Worked on E-GeMS	3-4?	7/15		
	Worked on E-GeMS and made many	6+	7/20	96& 98	

	improvements on layouts				
	Worked on E-GeMS	3	7/21/11		
	Worked on E-GeMS	5	7/25/11		
Neil Johnson	Worked on E-GeMS and had 2 nd meeting with Neil Johnson to trouble shoot research products	5	7/26	99&100	
	Worked on E-GeMS	3	7/28/11		
Don Rimstidt	Worked on E-GeMS and spoke with Don Rimstidt regarding run materials and standards. Also began official documentation and behind the scenes cleanup.	6.5	8/1/11	101&102	
	Worked on E-GeMS		8/2/11		
Neil Johnson	Worked on E-GeMS and had 3 rd meeting with Neil Johnson regarding research products. Discussed a user assessment..		8/3/11	103	
	Worked on E-GeMS	5.5	8/7/11		
	Worked on E-GeMS and wrote out more of the documentation of how to create tables, relationships, portals, scripts etc. Need to type this up. Also created current equipment and teaching materials.	6?	8/8/11		
	Feedback from family again	1	8/11/11		
Kurt Christensen	With Kurt Christensen's help, major breakthrough regarding custom dialogue and reverting changes	5	8/14/11	109	
	Worked on E-GeMS, Tested and fought with the change history	5	8/15/11	110	
Richard Godbee	Worked on E-GeMS and with Richard Godbee's help SOLVED the change history problem. (Needed to use variables)	1.5	8/17/11	110	
	Worked on E-GeMS making change tables, scripts, and layouts for all materials	3	8/18/11		
	Worked on E-GeMS	6+	8/20/11		
	Worked on E-GeMS, created all tables, fields, layouts, buttons, scripts, etc for Library and Archives. Also tray labels for Minerals	7.5+	8/21/11	111	
Butch	VMNH trip for interview, also met with Butch to review changes to E-GeMS and see what VMNH would need if they were to use it.	2	8/29/11	113	

	Worked on E-GeMS, created all tables, fields, layouts, buttons, scripts, etc for Historic Items		8/30/11		
Llyn Sharp	Reviewed E-GeMS with Llyn Sharp		9/1/11	114	
	Found Fossil Database and worked on IP brainstorm	3+	9/2/11		
	Worked on E-GeMS, worked on Fossils	5+	9/3-9/4		
	Worked on E-GeMS	10	9/5/11		
Jackie	Showed Jackie fossils in E-GeMS, finished the validations and thus finished the beta version of E-GeMS! also spoke with Phil White regarding IP rights		9/6/11		
	Meeting with Bob and Llyn regarding final beta version of E-GeMS and graduation and Denver		9/9/11	119	
	Made E-GeMS logo and handout for Denver	5-6?	9/13-9/14/11		
Jamie Nelson, Jolyon Ralph, Julian Gray, Bruce Geller, Jeff Self, Bill Dameron, Darci Moore, Al Liebetrau, Mark Candee	Denver Gem and Mineral Show, see report on the many museum professionals who saw E-GeMS and provided feedback. Also went to SMMP meeting.	7-8? (Hours discussing/showing E-GeMS)	9/14-9/19/11		
	Updated this log		9/26/11		
Keith William	Showed E-GeMS to Keith and discussed its potential market (~5-8,000 in the US with serious Mineral Collectors)	1.5	9/28/11	124	
	Prep for meeting with Steve and brainstorm on IP rights and the future of E-GeMS		9/29/11	125	
Bob Tracy	Met with Bob briefly to discuss the user assessment and who may be good candidates to take it		10/3/11	Pg 128	
Steve Lockett	Meeting with Steve Lockett from VTIP to discuss possibilities for E-GeMS and ownership/copyright/and other IP rights		10/4/11	Pg 125-127	
	Worked on User Assessment and Address Book Scripts	3	10/7/11		
	Worked on various layouts	3	10/8/11	Pg 130	

	Met with Don Dalton and showed him EGEMS		10/13/11		
Carl Francis	Met with Carl Francis from The Mineralogical Museum at Harvard University when he was visiting.		10/14/11	Pg 132	
Committee	–Pre-Defense Meeting” Reviewed thesis, plans for graduating, and conferences. (Ended up moving defense to following semester)		10/21/11	Pg 135 and see additional notes	
	Began administering the user assessments		10/25-10/26/11		
Jim Beard, Joe Kieper	VMNH trip to discuss post graduate position as geological collections and database specialist		11/1/11	Pg 143-146	
	Finished administering the user assessments		11/4/11		
	Began working on EGEMS website		11/4/11	Pg 149	
	Worked with Richard Godbee on Fixing the loan sort and layout with portal for loans		11/13/11		
	Worked on EGEMS Demo		11/14/11		
Jake Timm	Thanksgiving Break showed EGEMS and demo to cousin Jake		11/26/11		
	Full Layout Reconstruction with new picture icons for navigation and more smooth a transition from layout to layout	3	12/5/11		
	Worked on EGEMS Demo and website		12/6/11		
Jim Langridge, Richard Godbee, Llyn Sharp and Bob Tracy	Meeting to discuss networking in the department and security for EGEMS		12/8/11		
Llyn Sharp	Worked with Llyn on EGEMS, mostly going over security and admin rights. Tried to network un successfully, and worked on the new icon layout		12/9/11		
	Worked on EGEMS	3	12/10/11		
	Worked on EGEMS	12	12/11/11		
	Was able to network successfully through ODBC, had issues networking the usual way. Also worked on the demo in innovation space.		12/12/11		
	Worked on the demo in innovation space		12/13/11		

	Finished EGEMS demo in innovation space		12/14/11		
	Troubleshooted networking problems with EGEMS and fixed use with formulas authority file, also made backup of EGEMS considered locked and archived. As of today MoGs has been given full access to use EGEMS.		12/15/11		
John Leibold	Over winter break met with my cousin John Leibold.		12/29/11		
John Geikler	Met with John Geikler at VTIP		1/10/12		
	Met with Llyn, after EGEMS was being used in MoGs without my constant supervision, to review a few problem areas and clarify where things were unclear. Overall though it seemed to be going very well. Though I will make changes over time, at this point EGEMS is implemented successfully in the Department of Geosciences at Virginia Tech and being used as the official repository for Museum of Geosciences collections!		1/27/12		

APPENDIX C
ADMIN USER MANUAL

EGEMS Admin User Manual

(To be used in conjunction with a FileMaker guide)

TO CREATE A NEW “MATERIAL”

1. Under **manage database** (Ctrl+Shift+D) create table.
2. Under **manage database** (Ctrl+Shift+D) create fields.
 - **Create at least one field in the table before making the accompanying layout, otherwise FileMaker won't create the main table.
 - **When creating fields, it can be helpful to refer to the previous tables.
 - **In order to have the ability to insert images and other files, you must create **container** fields.
3. Set up a unique record number.
 - a. Make a number field
 - b. Select **options**
 - i. Check the **serial number** box
 - ii. Check the **generate on creation** circle
 - iii. At the bottom select **prohibit modification of value during data entry**
 - c. Select the **validation tab**
 - i. Uncheck the **allow user to override during data entry**
 - ii. Check **unique value**
 - iii. Select **ⓧ**

The field should now say **Indexed, Auto-enter Serial, Can't Modify Auto, Unique

TO CREATE A NEW “LAYOUT”

1. Under **layout mode** (ctrl+L) create layout
 - a. At the top select **new layout/report**
 - **Be sure to select the table you want the majority of your fields to be from.
 - **If you have a layout you are mimicking, you can copy and paste from the original layout.
 - **You must choose your layout type depending on what view you wish the layout's default display to be. EGEMS is mostly in **standard form** or **list view**.
 - **Most of the text is Ariel 12, 14, or 18, and all of the labels are bolded. This is not likely the settings you will start with and is again why if you can, it's best to copy and paste.

TO CREATE A NEW “AUTHORITY FILE”

1. Under **layout mode** select a field (double click) the inspector toolbar should appear.
 - a. At the top of the inspector tool bar select the **data** tab
 - b. In the first section, labeled **field**, select the box that usually says **edit box**
 - c. A drop down list will appear, select **drop down box** from this list
 - d. Where it says **values from** either select from a previously made authority file (also referred to as a value list) or create a new one

- e. To create a new file, click on the button with the pencil icon, a pop-up window should appear
 - f. At the bottom left of this window select the first button, labeled “new” and create a name for this new authority file
 - g. If your file will exceed 30,000 characters you will need to make it using the “use values from field” option and import your list from excel into a new table.
 - h. If your file will not exceed 30,000 characters you may paste it into the white box. For example if you would like the user to select a month, paste the 12 months in the format you desire. *One month per line.
- **To create yes/no check boxes, instead of selecting “drop down box” select “checkbox set”
- **All fields with drop down boxes will allow you to select “include arrow to show and hide list” “allow editing of value list” and “auto-complete using value list”. It is to your discretion to select these, most fields in EGEMS with drop down lists have all of these selected.
- **If you created your authority file from a table the user will not be able to edit or add to it unless you create a layout with the ability to do so. You can create buttons to link one layout to the next, see below “To create a new button”.

TO CREATE A NEW “RELATIONSHIP”

1. Under “manage database” (Ctrl+Shift+D) select the “relationships” tab, this will bring up the entity relationship diagram (ERD).
 - a. On the bottom of this diagram there are a series of buttons, select the second one from the left, to bring up the “edit relationship” box.
 - b. In this box, in the first dropdown menu labeled “Table” select one of the tables you wish to relate, as well as the field.
 - c. In the next box select the related table and field.
 - d. The small box in the middle with the equal sign should not change.
 - e. Once you have the two fields selected, click on the “add” button underneath. This creates the relationship.
 - f. To define the relationship further you may select from the check boxes at the bottom.
 - g. Click “Ok” when you are done, and notice how this relationship is now being illustrated in the white space.
- **Relationships are what makes the EGEMS a database and not a flat file. In order for records from one table to show up on a layout whose primary table is not this table, there must be a relationship.
- **Relationships need to be set up correctly and can take some trial and error, if a field is not displaying information from a related table it is more than likely the relationship is not correct.
- **FileMaker does not allow for relationships to cycle, in order to circumvent this problem in EGEMS I created the ID table, so if you need a new table to relate but it can't because it will create a loop, then simply create a new ID type and link that instead.

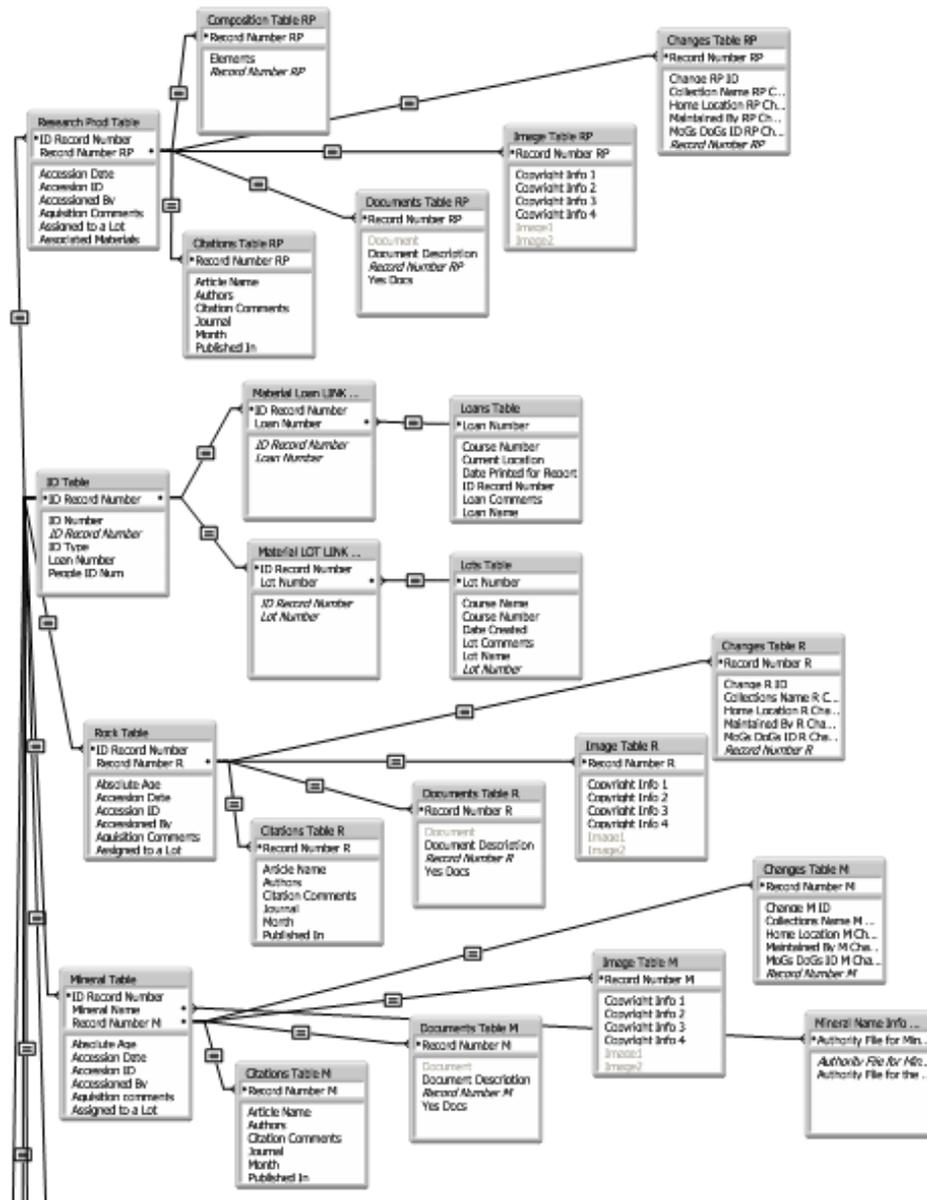
TO CREATE A NEW “PORTAL”

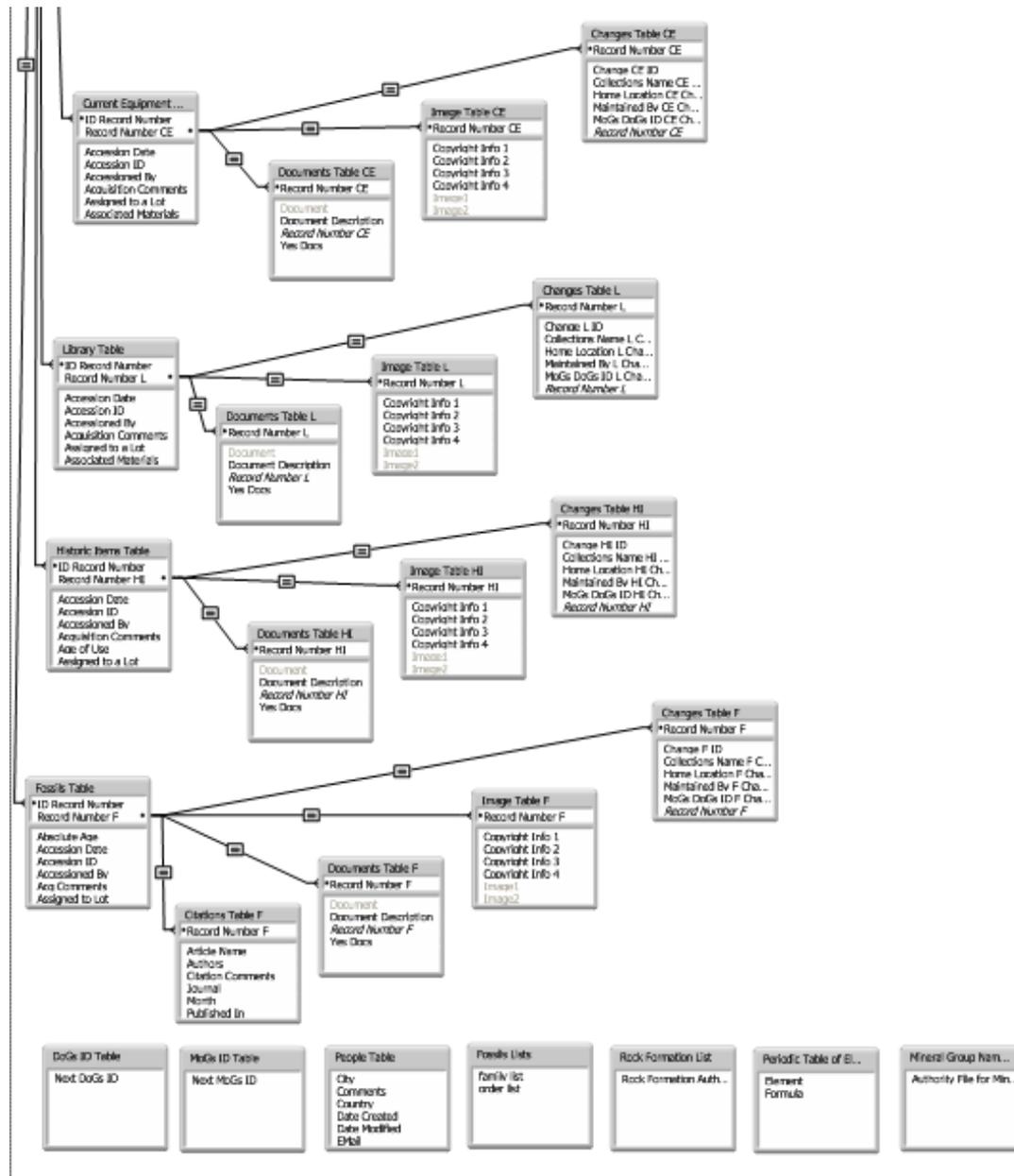
1. Under “Layout mode” (Ctrl+L) insert portal.
 - a. Select the table you want to show records from, and how you want them to sort. Select “show vertical scroll bar”.
 - b. Move the fields inside the grey portal box if they are not already.
 - c. Portals will show up as grey boxes with the fields chosen inside them. If the fields are moved outside of the portal they no longer work with the portal.
**Portals require the relationships to be correct, the portal box and the fields within it to be coming from the same table, and the fields to be within the portals boundaries. There are many things that can go wrong in creating a portal, but when done right they are powerful tools. Portals allow the user to view multiple records from a related table. Without portals, EGEMS would have no way to display the materials out on loan or associated with a lot.

TO CREATE A NEW “BUTTON”

1. Under “Layout mode” (Ctrl+L) insert button, or select from the toolbar on the top of the screen the button which has a hand over a rectangle, if you scroll over this it will say “button tool”.
2. Draw the shape of your button with the crosshairs, when done the “button setup” menu should appear.
3. Select what you would like the button to do, EGEMS mostly uses buttons to bring a user from one layout to the next. To set this up, select “Go to Layout” from the list. Under “specify” select “layout” and then select which layout from the list that pops up.
4. Once you hit Ok and get back to the layout view, the button will have a blinking cursor over it, this is so you can type when you want the button to say.
**Buttons do not have to be just text, you can make any layout object into a button. EGEMS uses universal icons as buttons to navigate to the home page, address book, create a new record, and perform a find.
**Buttons can also trigger scripts, (refer to a FileMaker guide for more information on scripting).

ENTITY RELATIONSHIP DIAGRAM (ERD) FOR EGEMS, NOT TO BE COPIED OR DISTRIBUTED





APPENDIX D
DENVER, COLORADO REPORT

All professionals below have seen E-GeMS and provided some form of feedback. It has been mentioned that the South Dakota School of Mines and LA County Museum may also be looking to change to a newer database. The parenthesis at the end of the comments is the database currently in use at that institution.

Institution	Person	Position	Contact Info	Notes/Comments
AMNH American Museum of Natural History	Jamie Newman	Senior Scientific Assistant, Minerals and Gems	Jamien@amnh.org 212-769-5386	Feels strongly that her department database needs to change soon. She provided very good feedback on E- GeMS and said she would be in touch. (Superbase)
CSM Colorado School of Mines	Bruce Geller	Geology Museum Director	geomuseum@mines.edu Phone: (303) 273 - 3823	Said he was impressed and would be in touch. (Superbase?)
Mindat	Jolyon Ralph	Founder	jolyon@mindat.org	Said he was impressed and provided good feedback and suggestions. He also suggest collaborating with Mindat to provide an online service to museums, collectors, and the public. (Mindat)
UA Mineral Museum University of Arizona	Mark Candee	Curatorial Specialist	mcandee@email.arizona.edu Phone: (520) 621-4227	Said he was impressed and provided good feedback (Uses an old filemaker database, he said he E-GeMS "can do so much more" and he is much more impressed with E-GeMS)
Tellus Science Museum	Julian Gray	Curator	Juliang@tellusmuseum.org 770-606-5700 ext 415	Expressed interest and agreed that "the need is out there, especially if you collaborate with Mindat." (Superbase?)
Collector of Fine Minerals	Al Liebetau	Private Collector	Liebetaum@msn.com	Said he was impressed with E- GeMS simplicity. (SaskLithic)
California State Mineral and Mining Museum	Darci Moore	Museum Curator	dmoore@parks.ca.gov 209-742-7625	Said she was impressed and provided feedback. (Superbase? Pastperfect?)

Rice Museum Northwest	Bill Dameron	Board Vice President	baritebill@comcast.net	Said he was happy with its easy ability to search and also thinks "the ability to convert from Superbase to a program which one could expect continued support over the years is very important." (Superbase)
Friends of Mineralogy	Jeff Self	Colorado Chapter, Preservation Committee	selfawareminerals@gmail.com	Was hugely happy with E-GeMS and is considering using it to help with the work of the Preservation Committee. See their wonderful article on "The future of our collections" http://rockunandgemunwetblog.com/tag/minerals

APPENDIX E
USER ASSESSMENT

E-GeMS User Assessment

To evaluate usability of E-GeMS and ease of locating materials using E-GeMS I have developed a short user assessment. Please take the time necessary to complete all of the sections. When you are finished and have handed it in you will receive a thank you reward!

Part 1. Usability of E-GeMS

A. To begin, start by clicking buttons and navigating freely through E-GeMS. Acquaint yourself with the various screens and using the scale below please rate the overall appearance of E-GeMS.

1 2 3 4 5 6 7 8 9 10
Very Poor Well Done

B. Now that you have had some experience viewing the screens, please answer the following questions. In most cases there is more than one way to go about finding the answer; please provide the answer and then some information on how you achieved it and how easy it was to do so.

1a. How many rocks are from Virginia? _____

1b. Which screen did you use to come to this conclusion? (Please Circle or Explain)
Full Screen Quick Screen Browse Screen Other _____

1c. Using the scale below please rate the ease with which you came to this conclusion.

1 2 3 4 5 6 7 8 9 10
Difficult Easy

2a. Where is the mineral with ID number 5013 located, and, what is its locality name?

2b. Which screen did you use to come to this conclusion? (Please Circle or Explain)
Full Screen Quick Screen Browse Screen Other _____

2c. Using the scale below please rate the ease with which you found these answers.

1 2 3 4 5 6 7 8 9 10
Difficult Easy

2c. What is the shape of the stand this material is currently displayed on? (Please Circle or Explain)

Rectangle Circle Square Other _____

.....

3. It is important that E-GeMS be able to capture information for many different geologic materials, including synthesized research products. Please locate, with the help of the person who maintains it, the synthetic powder labeled TTD-1.

3a. Who maintains this material?

3b. Which method of contact did you use? (Please Circle or Explain)

E-Mail Phone In Person Other _____

3c. How many days did it take to contact the person who maintains this material and locate it?

.....

Please provide any additional suggestions or comments here:

Thank you so much for taking the time to complete this user assessment. Please hand it in to me at your earliest convenience to collect your reward!