NM WRRI Student Water Research Grant Progress Report Form
Progress Report due Feb 1, 2017
Draft Final Report due June 1, 2017
Final Report due June 30, 2017

1. **Student Researcher**: Nhat Nguyen
   Faculty Advisor: Dr. Antonio Lara

2. **Project Title**: Uranium Abatement for Contaminated, Limited Water Resources Using Clay Pellets

3. **Description of research problem and research objectives.**

   Clean potable water is scarce on the Navajo Nation forcing people to consume uranium-contaminated water with levels greater than 30 ppb. The result is an epidemic known as "Navajo neuropathy" along with other serious health related problems. Natural clays have proven to be a great sorbent with excellent ability to sorb heavy metals, especially uranium, via their unique cation exchange capabilities. This is a cost-effective means to clean water resources using clays that can be easily obtained locally. Although effective, clays themselves are difficult to physically manage. Thus, clay pellets are being fabricated.

   Temperatures play a significant role in clay pellets formation. Precise dehydroxylation temperature is the essential key for this process. If the clays were fritted under insufficient temperature and time condition, the pellets would not be robust enough. On the other hand, if they were fritted at a too high temperature or for too long, they would turn into glass thus also resulting in substantially decrease of heavy metals abatement rates. The TGA-DSC instrument is used to monitor how different clays behave at different temperatures over time.

   For our study, three well-known, well-studied reference clays and two regional clays are being utilized. Arizona, Texas, and Wyoming represent reference clays while Gallup and Berino (New Mexico) are used for regional clays. With their own unique chemical and physical characteristics, each clay needs to be analyzed individually and precisely. Currently in our lab, Gallup clay is being analyzed to set up initial protocols for later analysis of other clays.

4. **Description of methodology employed.**

   All clay samples are ground and sieved to a particle size below 100 μm. The thermal characteristics of the naturally occurring Gallup clay were studied using the NETZSCH STA 409 PC Luxx. The dynamic experiments are carried out at heating rates of 10, 15, 20, and 25 $K*min^{-1}$. All raw powder clay samples are heated up to 850°C. Changes in mass and energy are also monitored.

   Previous studies show that dehydroxylation can occur at either around 500°C or around 700°C, or twice between 500°C and 700°C depending on the type of clay. Most montmorillonites have two dehydration stages which complete at 100°C and 150°C. Sepiolite also has two dehydration stages (complete at 98°C and 564°C) followed by one dehydroxylation stage (up to 822°C).

Bentonite, on the other hand, has a complex dehydration process with two overlapping stages (complete at 173°C) and a single stage dehydroxylation reaction (up to 814°C).

5. **Description of results; include findings, conclusions, and recommendations for further research.**

Gallup clay powder

Heating Rate (K/min)	Dehydroxylation Process				
	Start (°C)	Peak (°C)	End (°C)	Mass Loss (%)	Energy (mW/mg)
10	607.7	634.7	662.1	2.60	0.09623
15	622.0	650.9	695.9	2.37	0.1011
20	637.8	673.2	708.9	2.24	0.0907
25	644.3	680.6	698.4	1.71	0.1597
Average	628.0	659.9	691.3	2.23	0.1119
Standard Deviation	16	21	20	0.4	0.03

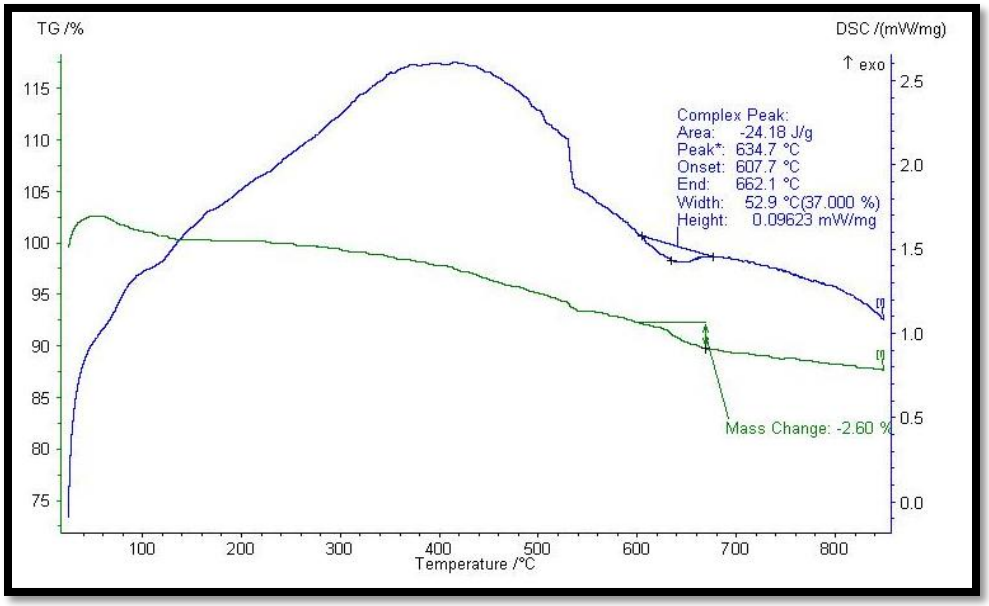
Arizona clay powder

Heating Rate (K/min)	Dehydroxylation Process				
	Start (°C)	Peak (°C)	End (°C)	Mass Loss (%)	Energy (mW/mg)
10	565.7	638.8	669.5	2.22	0.04618
15	558.7	634.0	683.5	2.76	0.0823
20	581.9	631.9	677.9	2.33	0.1244
25	588.4	644.9	685.5	2.14	0.1067
Average	573.7	637.4	679.1	2.36	0.0899
Standard Deviation	14	6	7	0.3	0.03

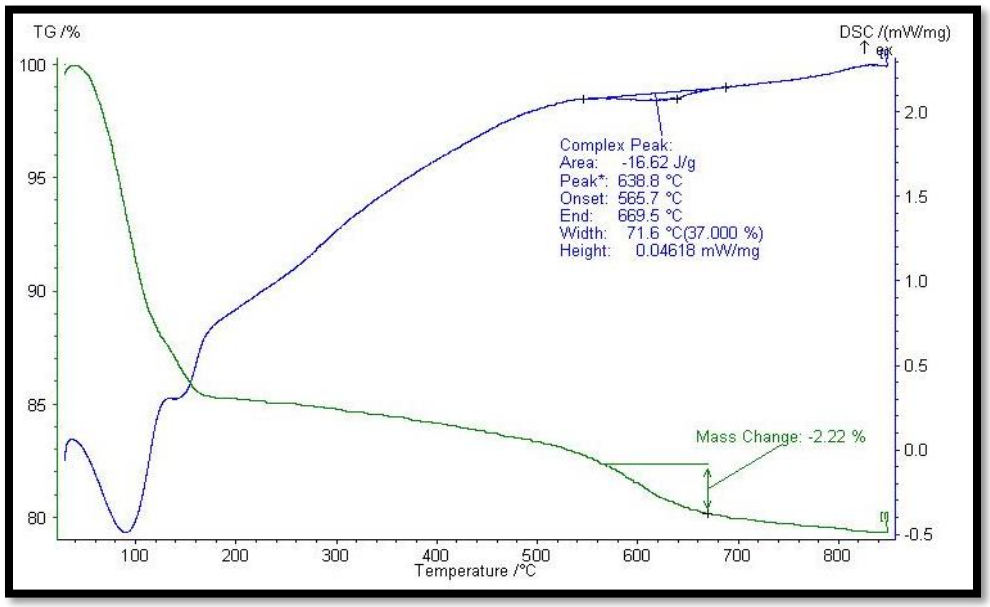
Graphs

Heating rate 10 K/min

Gallup

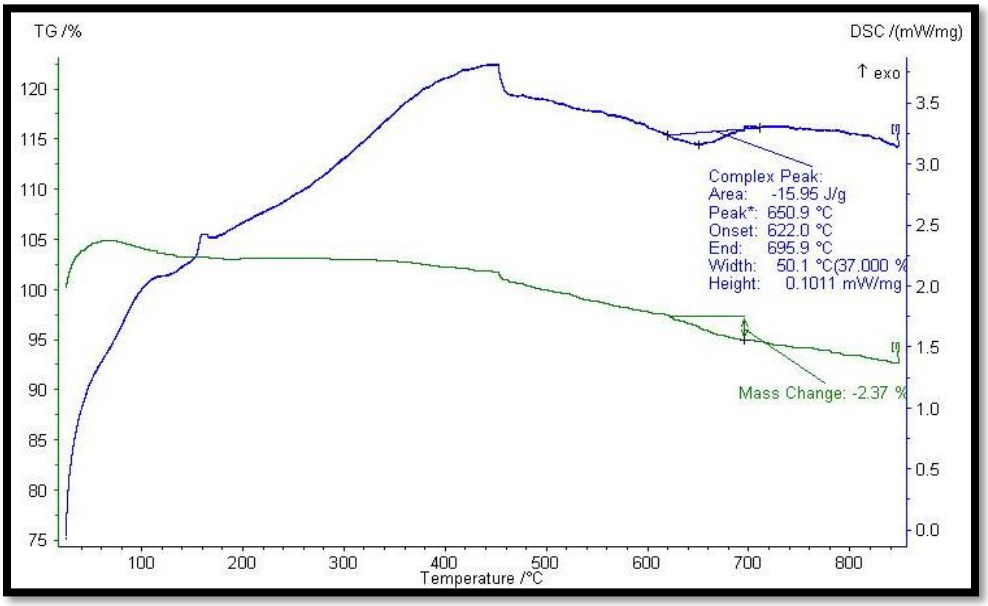


Arizona

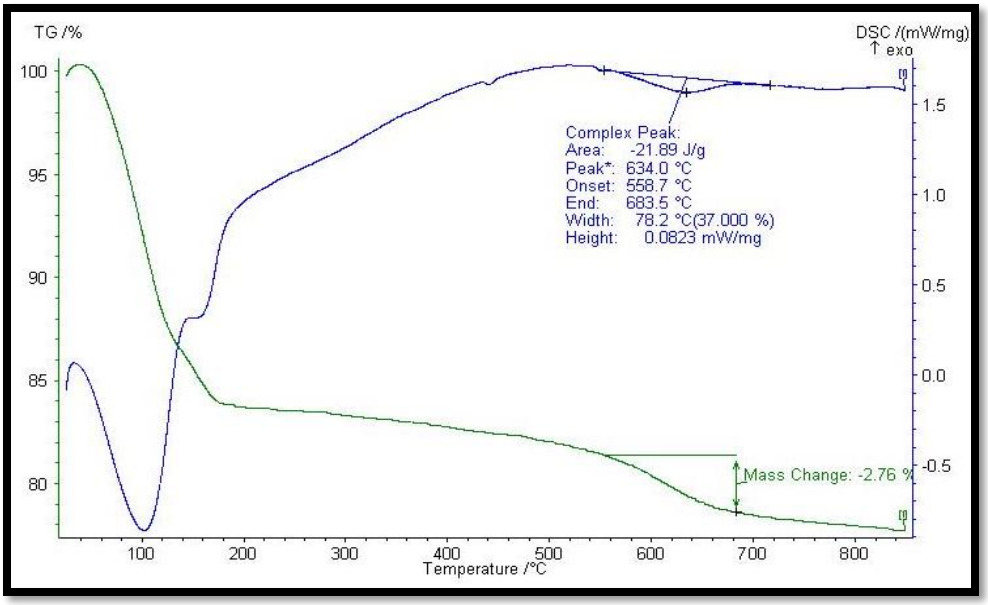


Heating rate 15 K/min

Gallup

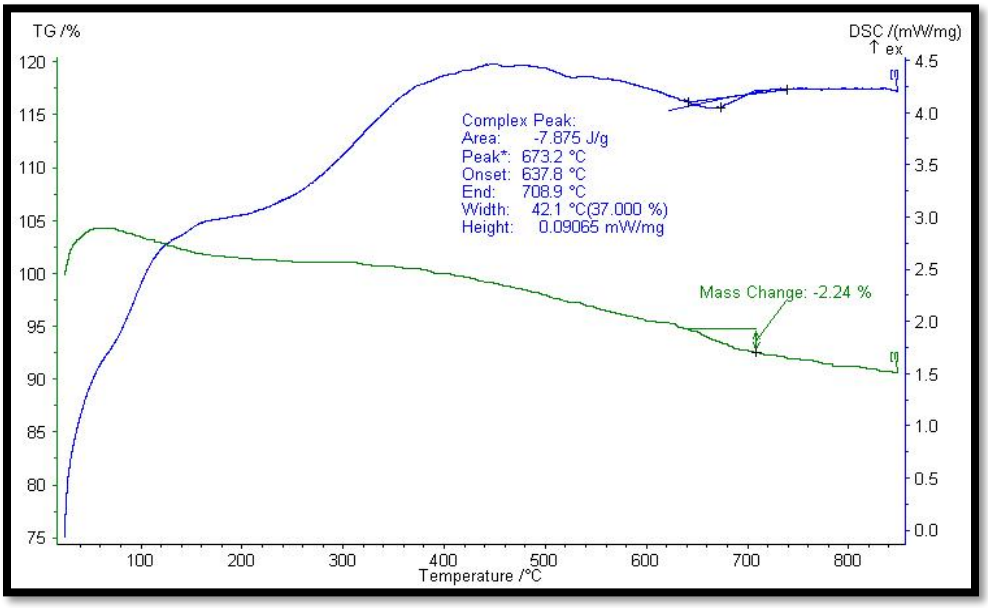


Arizona

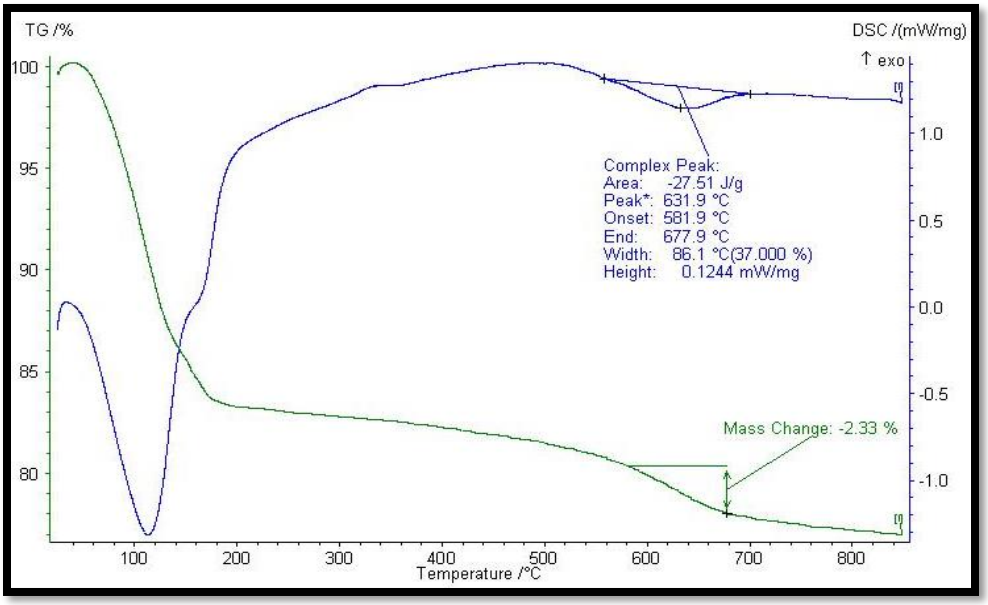


Heating rate 20 K/min

Gallup

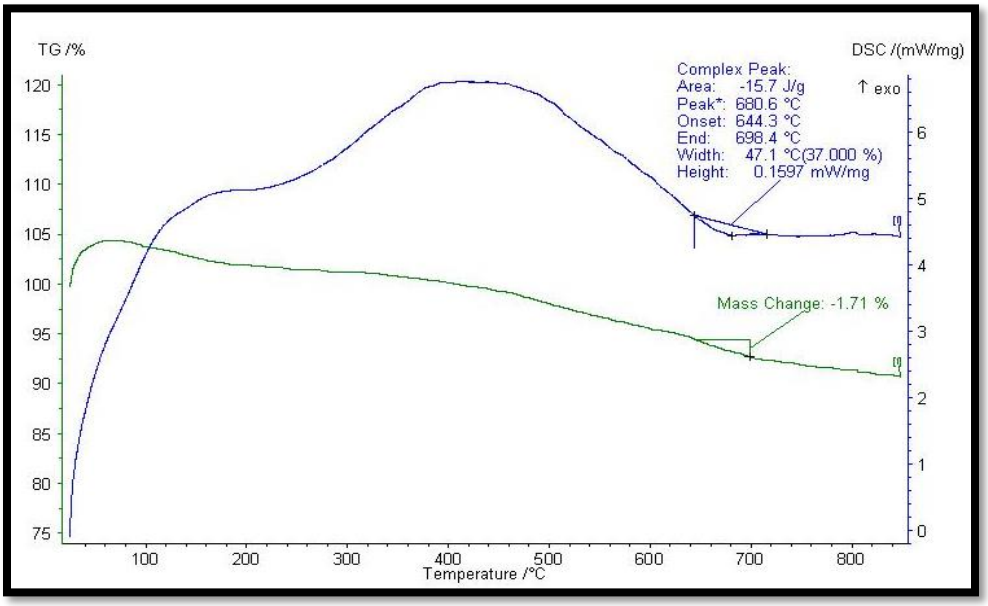


Arizona

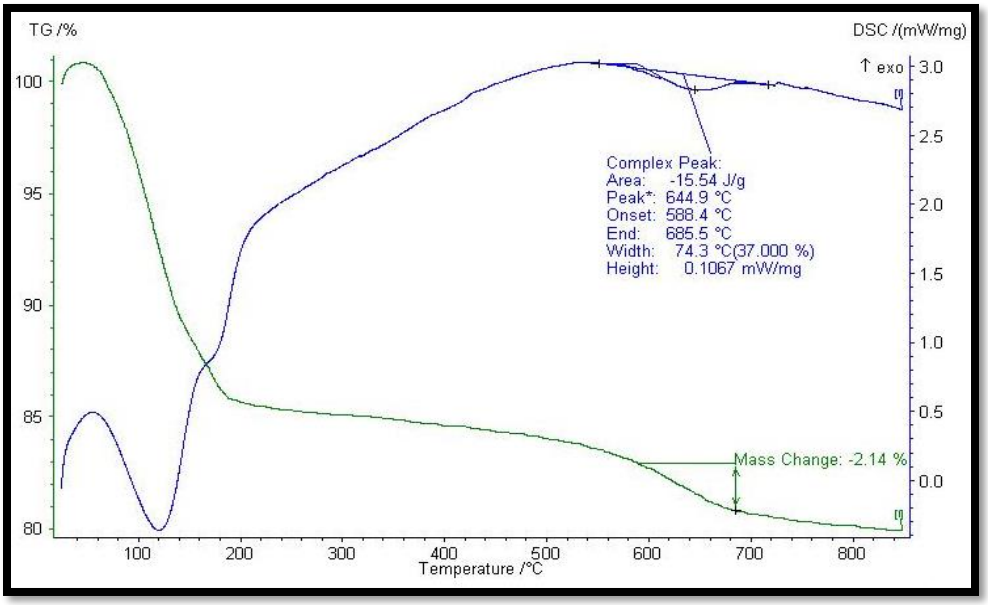


Heating rate 25 K/min

Gallup



Arizona



Another team in our lab is currently investigating on water to clay ratio to find out the optimal ratio which would give the best pellet for both robustness and uranium sorption. My future research would be doing TGA/DSC study on the best water to clay ratio for Gallup clay. The best ratio for robustness of Gallup clay pellet has been determined which is 65% clay to 35% water. Right now, we are still waiting on the result of sorption tests. Meanwhile, I have done a few preliminary TGA/DSC runs on Arizona clay powder as included in this report. Next, different acquisition rates will be investigated to optimize the dehydroxylation peak for better analysis. Further investigation on dehydroxylation mechanism would also be another possible future project.

6. **Provide a paragraph on who will benefit from your research results. Include any water agency that could use your results.**

   The most beneficial target for our project would be people within the Four Corners area. Clean water is scarce, especially in the economically limited Navajo Nation. Alternative potable water options and sources are restricted; hence, people often must consume the heavily contaminated water. Our clay pellets can provide a cost-effective means to clean water using clays that can be easily obtained locally.

   Even though our main target is people in the Navajo Nation, the potential of clay pellets is limitless. Preliminary test runs have given us sorption results for other heavy metal other than uranium such as lead and cadmium all below the EPA standards for safe drinking water.

7. **Describe how you have spent your grant funds. Also, provide your budget balance and how you will use any remaining funds**

   There would be no left-over fund by the end of June 1, 2017. All the fund has been broken down below.

   Salary: $4,747.77
   Description: the salary have been distributed out evenly per hour until June 1, 2017.
   Fringe Benefits: $52.23
   Analysis: $1,200
   Description: Isotope Analyses by Dr. Ramos of the Department of Geological Sciences (Invoice was submitted; waiting to be finalized)

8. **List presentations you have made related to the project.**

   2016 New Mexico AMP Conference at NMSU
   2017 ERN Conference in STEM
   2017 URCAS Conference at NMSU

9. **List publications or reports, if any, that you are preparing. Remember to acknowledge the NM WRRI funding in any presentation or report that you prepare.**

   None at the moment.

10. **List any other students or faculty members who have assisted you with your project.**

    Faculty members: Dr. Antonio Lara, Dr. Raul Rivera
    Students: Jeremy Jones, Tiffany Fowler, Moticha Yellowman, Karen Ramirez

11. **Provide special recognition awards or notable achievements as a result of the research including any publicity such as newspaper articles, or similar.**

    Abstracts and posters were accepted and presented at the 2016 New Mexico AMP Conference at NMSU, 2017 ERN Conference in STEM, and 2017 URCAS Conference at NMSU.

12. **Provide information on degree completion and future career plans. Funding for student grants comes from the New Mexico Legislature and legislators are interested in whether recipients of these grants go on to complete academic degrees and work in a water-related field in New Mexico or elsewhere.**

    I am expecting to be graduated by May of 2018. After graduation, my plan is to apply for either an MD/PhD program or just a PhD program. I am currently preparing to take both the MCAT and GRE exams this summer of 2017.