



John O. Voigt, Executive Director  
105 Apple Valley Circle  
Clarks Summit, PA 18411, USA  
Phone: +1 570-585-8092  
Email: [jvoigt@solutionmining.org](mailto:jvoigt@solutionmining.org)

Leo L. Van Sambeek, Research Coordinator  
381 Fairgrounds Place  
Hermosa, South Dakota, USA  
Phone: +1 605-484-2516  
Email: [LeoVS@solutionmining.org](mailto:LeoVS@solutionmining.org)

## **SMRI Request for Proposals (RFP2017-2)**

### **“Update SMRI’s Correlation of Chemical, Mineralogic, and Physical Characteristics of Salt to Deformation and Strength Properties”**

#### **Background**

This Request for Proposals (RFP) is issued based on SMRI's Research Committee and Executive Committee approvals at their April 2017 meetings in Albuquerque, New Mexico. In early 1995, SMRI accepted a final research report entitled “Correlation of Chemical, Mineralogic, and Physical Characteristics of Gulf Coast Dome Salt to Deformation and Strength Properties” prepared by RESPEC Inc. (Pfeifle et al, 1995)<sup>1</sup>.

Strength and deformation properties of the salt in the immediate vicinity of underground structures are important quantities for the successful design and analysis of underground excavations. The strength and deformation properties of salt are known to be site dependent. Although the origin of this variability is not well known, the differences in strength and deformation properties of salt were shown to correlate to more easily measured chemical, mineralogic, and physical characteristics of the salt.

The strength and deformation properties included in the previous analyses were indirect tensile strength, unconfined compressive strength, angle of internal friction, cohesion, elastic moduli including Young's modulus and Poisson's ratio, steady-state-creep properties (strain rate, stress-exponent, and activation energy parameter). The chemical constituents considered in the analyses were sodium, chlorine, magnesium, potassium, calcium, sulfate, and water insolubles. Although natural rock salts contain many different minerals, only two mineralogic characteristics, halite and anhydrite, were included in the study because of the purity of the Gulf Coast dome salts. Physical characteristics examined included mean grain size, grain size variability, grain aspect ratio, and sub-grain size.

Correlation coefficients were the statistic used to quantify all correlations between salt characteristics and the deformation and strength properties. The correlations were grouped into four major analyses: (1) certain strength and deformation properties versus other strength and deformation properties; (2) strength and deformation properties versus chemical constituents; (3) strength and deformation properties versus mineralogic characteristics; and (4) strength and deformation properties versus physical characteristics. Other correlations (e.g., chemical constituents versus chemical constituents, chemical constituents versus mineralogic characteristics, etc.) were determined as by-products of these four major analyses and were reported in a comprehensive correlation coefficient matrix.

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<sup>1</sup> Pfeifle, T. W., T. J. Vogt, and G. A. Brekken, 1995. *Correlation of Chemical, Mineralogic, and Physical Characteristics of Gulf Coast Dome Salt to Deformation and Strength Properties*, SMRI Research Report 94-0004-S, prepared by RESPEC Inc., Rapid City, South Dakota, January, 140 pages.

The research report has been used in geomechanics studies for cavern designs and cited in regulatory applications. Now, more than 20 years later, SMRI is requesting proposals to update that research project based on new testing information available from both Gulf Coast salt domes and all other salts (dome and bedded salts.) While the previous research report provides a framework for expanding the analysis to include additional salt information, the technical approach is not limited to merely repeating the analysis in the same way. Proposers are free to propose alternative methods and describe the benefits from changing the analysis method. This is particularly significant if salts other than Gulf Coast domes are included.

A copy of Pfeifle et al (1995), SMRI Research Report 94-004, can be obtained by contacting the SMRI Executive Director (see letterhead above). A charge of US\$150 will be assessed non-members requesting a copy of research reports (the charge represents ½ percent of the original research project cost).

## **Scope of Work**

Proposals submitted in response to this RFP must answer or discuss (at a minimum) the following questions or points related to the update:

- How will additional salt information be collected? What types of information is expected to become available? What are the likely sources of the additional information? Have these sources already been contacted to obtain at least preliminary agreement on release of information?
- What type of database structure for information is suggested? Is a spreadsheet adequate? How will the database be included in the research report or how can it be made available, but still be protected?
- What software will be used for the analysis (must be open source or commercially available to members and reasonably priced)?
- Describe how the research results will be presented and then used by industry.
- Is the correlation approach used by Pfeifle et al (1995) still appropriate, or is there a better way?
- While the previous research report provides a framework for expanding the analysis to include additional salt information, the technical approach is not limited to merely repeating the analysis in the same way. Proposers are encouraged to propose a more contemporary method and describe the benefits expected by changing the analysis method. An example in your proposal using, some of the data from Pfeifle et al (1995), would be illustrative.
- Obviously, the research project cannot cover all salts in the world, but could cover a reasonable sampling of “any” salt that the researchers have access to the requisite information. To be included, a salt should already have existing information on both its “characteristics” and its “mechanical properties,” which must be publishable (identifiable by salt-formation name and non-confidential). Some allowance (see Task 3) is made for measuring salts’ characteristics as part of the research, since filling in the missing characteristics is very economical in order to qualify a salt that already has its expensive mechanical properties information. Each proposer will need to describe how they have (or will) select which salts to include within their fixed-sum contract. The descriptions of which salts are to be included or discussions of how they will be selected will naturally be part of the proposal evaluations and contractor selection.

The proposal should subdivide the research into manageable tasks (and options) with timelines for tracking task progress. Four suggested tasks follow:

Task 1: Contact industry and government sources to obtain additional salt information. This task includes identifying sources, describing the type of information sought, requesting information, and documenting permission to use that information in the research (including what might currently be considered confidential data).

Task 2: Compile a new database of strength and deformation properties and chemical, mineralogic, and physical characteristics of salts (e.g., density, porosity, etc.). The database will begin with the appropriate information from Pfeifle et al (1995) and add the new information.

Task 3: Perform (or subcontract) supplemental laboratory work to obtain chemical, mineralogic, and physical characteristics for relevant salts if these characteristics had not been determined previously. This task is not intended to measure additional deformation and mechanical properties.

Task 4: Perform correlation analyses using available software (open source or commercial) to prepare the research report. The analyses might need to separate bedded from domal salts, in addition to mineralogy.

## **Proposal Instructions**

Responses to this RFP should be reasonably brief (less than 10 pages); describing the proposed effort, a succinct discussion of the technical approach, the project schedule and cost, and the proposer's qualifications for executing the effort. This RFP anticipates that a fixed-sum contract will be used<sup>2</sup>. The qualifications and experience of the proposed researcher(s) in the technical fields of statistics and salt mechanics are likely the most significant proposal-evaluation criteria. Teaming and subcontracting to bolster qualifications are encouraged, but a strong lead researcher (project manager) must be identified in the proposal and will be named in the research contract as a key personnel. The level of commitment of the lead researcher to the research effort must be itemized in the proposal.

Proposals should be submitted in electronic form via email to Dr. Leo L. Van Sambeek, SMRI Research Coordinator, (LeoVS@solutionmining.org), by December 1, 2017. Please email a statement of your interest or intentions to respond to this RFP before September 15, 2017, so you receive any updates or modifications to this RFP. Questions relating to the RFP should be directed in writing (via email) to the Research Coordinator. Answers to questions that apply to all potential proposers will be forwarded to all identified proposers. Please state in your proposal whether or not SMRI may make your proposal (or portions thereof) available to our members and/or the public.

## **Contract Award and Contract Specifics**

Proposals will be evaluated solely on the basis of information contained in the proposal. The proposer selected for negotiation of a contract will be the one that best meets SMRI's needs and is economically sound. SMRI has the right to select or reject any or all proposals.

The research contract will be negotiated between the selected contractor and SMRI. The contractor will be solely responsible for coordination of any subcontracted work and for all payments to any subcontractor(s).

1. SMRI contract for this Work will be fixed-sum for the defined statement of work. The proposed fixed sum payment must be clearly defined in the proposal. Payment will be made upon acceptance by the Research Committee of the final research report. No other progress or interim payments would normally be made.

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<sup>2</sup> The task of obtaining missing chemical, mineralogic, and physical characteristics for relevant salts requires a "not-to-exceed" cost estimate as part of the total project cost. The expected unit price per measurement of a salt's characteristics should be provided together with an estimate of the amount of missing information. This cost may have to be re-negotiated after determining the exact amount of missing information.

2. SMRI's Project Sponsor will be named after contractor selection. The project sponsor will be the contact for any project-related communications.
3. The research project is to be completed within 24 months (or sooner) of the project start date; use an anticipated start date of July 1, 2018.
4. The contractor shall present progress reports at each SMRI Research Committee meeting during the project and an oral research report at the end of the project. The costs for these presentations, if any, are to be included in the fixed-sum cost of the project. The Project Sponsor or Research Coordinator may present one of the two required progress reports per year to the Research Committee using materials (text and PowerPoint) prepared by the project team.
5. A final research report is required in the form of a standard scientific or technical report. The research report will provide standard information such as background and purpose for the research, theoretical basis and methods, data collected, analysis, references, and research conclusions. Depending on the amount of information used, either lists of information in appendices or separate electronic files of the information, or both, might be required. The research report will be reviewed by the Project Sponsor, the Research Coordinator, and the Research Committee. Before final report acceptance, the researchers must satisfactorily address all review comments. All report submittals (drafts-for-review and final) will be as electronic files, both MS-WORD (\*.doc) and PDF (\*.pdf). SMRI will supply formats/contents for its standardized report covers, title pages, and forward/disclaimer for its research reports.
6. The enclosed Standard Terms and Conditions for SMRI Research Contracts, dated 30 June 2017, shall apply. Additional limitations or modifications are possible before contract negotiation.
7. SMRI retains ownership and copyright of the work products resulting from this research. Limitations on publishing and release of information are listed in the Terms and Conditions.



Leo L. Van Sambeek  
Research Coordinator

Enclosures:

Standard Terms and Conditions for SMRI Research Contracts, dated 30 June 2017

cc: John O. Voigt, Executive Director  
Fritz Wilke, SMRI President  
Klaus Buschbom, SMRI Research Chairman  
Members of the SMRI Research Committee