SERATA GEOMECHANICS CORPORATION

Automatic Stress/Property Measurement for Earthwork Optimization

CATEGORY 6 GLOBAL PROJECT RECORDS AND REFERENCES

— Records of Contribution from Three Decades of Fieldwork —

Serata Geomechanics Corporation
4160 Technology Drive・Fremont・California 94538 USA
Tel: (510) 659-8630 e-mail: serata@serata.com http://www.serata.com

6-1 GLOBAL PROJECT RECORD

List of Major Projects Utilizing Serata Stress Technology (SST)

Country/Organization	Project
AUSTRALIA	
Kembla Coal and Coke Woolongong, N.S. Wales	Underground coal mine design and development
CANADA	
Potash Corp. of Saskatchewan (PCS) Saskatoon, Saskatchewan	Design and development of four deep potash mines at Allan, Cory, Lanigan and Rocanville.
Sifto Canada, Inc. Goderich, Ontario	Mine design & instrumentation for rehabilitation of old failing operation.
SOQUEM, Les Mines Seleine Madeline Island, Quebec	Multiple-level salt mine design and development by eliminating surface subsidence.
Dow Chemical Canada Edmonton, Alberta	Solution mining design and analysis of large cavern field operation.
International Minerals & Chemical Esterhazy, Saskatchewan	Potash mine design and development overcoming rapid ground failure by stress control.
Potacan Mine, Ltd. Tracy, New Brunswick	Stabilizing failing ground by introducing Stress Control method.
ENGLAND	
Rio Tinto Zinc Corp. London	Potash exploration & mining feasibility analysis of the deep potash deposit under North Sea.
Cleveland Potash, Ltd. Boulby, Yorkshire	Development and design optimization of potash mining under the Yorkshire National Park.
INDIA	
Central Mining Research Institute Darnbad	Introducing Serata Stress Technology to the mining industry of India through the Institute.
JAPAN	
Japan Railroad Construction Bureau Hokkaido	Ground measurement and analysis for Seikan Undersea Tunnel excavation.
Chubu Power Company Hamaoka, Shizuoka	Stress and property measurement and safety analysis for nuclear power plant foundation.
Shikoku Power Company Ikata, Ehime	Stress measurement and analysis of foundation for nuclear power plant.

Ministry of Science & Technology, Japanese government	Automatic stress/property measurement for earthquake prediction.
Ministry of Land & Transportation, Tsukuba Research Center Japanese government	Stress measurement in tunnel ground for digital optimization of earthwork.
Ministry of Economy & Industry, New Energy Development Bureau Japanese government	Development of deepwell remote measurement system for Serata Probe.

NETHERLANDS

Royal Dutch shell Oil Co. Rotterdam	3-D material testing development for solution mining.
Akzo Zout Chemie Hemgello	Underground cavern design for petrochemical waste storage.

UNITED STATES

Dow Chemical Company Freeport, Texas	Cavern design and analysis for solution mining and underground storage of gas, oil and chemicals.
Bechtel Corporation Carlsbad, NM	Nuclear waste disposal (WIPP) Design and safety analysis, accurately predicted the ground failure.
U.S. Department of Energy (ONWI/Battelle) Richmond, WA	Nuclear waste storage design and construction analysis.
Electric Power Research Institute (EPRI) McIntosh, Alabama	Design and construction of the world first compressed air energy storage cavern in the world.
Peabody Coal Company St. Louis, MO	Digital optimization design and field adaptation for coal mining.
Jim Walter Resources Somerset. CO	Digital optimization of deep coal mining.
Genwal Coal Company Huntington, Utah	Design optimization of multiple-level coal mining.
Solution Mining Research Institute Encinitas, LA	Digital optimization analysis and design of solution caverns and safe operation.
Louisiana Offshore Oil Port New Orleans, LA	Design of solution cavern field for large scale oil storage.
Shell Oil Company Houston, Texas	Solution cavern design and analysis in offshore oil storage.
Trans Continental Gas Pipeline Co. St. Louis, MO	Gas storage cavern analysis and design and safety assurance.

6-2 PUBLICATION LIST ON SERATA STRESS TECHNOLOGY

1. Double-Fracture Method
   "Double-Fracture Method of In Situ Stress Measurement in Brittle Rocks"
   Author: Shosei Serata
   Source: Rock Mechanics & Rock Engineering, Vol.25, 1992, PP 89 – 108
   Significance: Detail explanation on invention of the method
2. Serata Probe Testing for Japanese Government Program
   "Investigation on a New Dry Single-Fracture Method of In-Situ Stress Measurement"
   Authors: T. Ishida, Y. Mizuta, and Y. Nakayama
   Source: Rock Stress Symposium, Kumamoto 2003
   Significance: Laboratory validation of Serata Probe in the Japanese government program
3. Remote Operating System of Serata Probe for Japanese Government Program
   "Development and Application of Load Test Equipment for 1,000 m Deep Borehole"
   Authors: N. Tsuda, T. Yoshimura, and T. Hatano
   Source: 9th Congress of EAEG 2002, 9, http://www.civil.ntua.gr/IAEG
   Significance: Field validation of the remote operating system down to 1,000 m depth
4. Serata Stress Technology (SST) Software (I)
   "Formulation of Constitutive Equation for Salt"
   Authors: Shosei Serata, Kittitep Fuenkajorn
   Source: 7th Symposium on Salt, Vol. 1 483 – 488 (1993), Elsevier Science Publishers, B.V., Amsterdam
   Significance: Basic concept of FEM modeling of structures in complex ground.
5. Serata Stress Technology (SST) Software (II)
   "Numerical Simulation of Strain-Softening and Dilation of Rock Salt"
   Authors: Kittitep Fuenkajorn and Shosei Serata
   Source: International Journal of Rock Mechanics and Mining Science, Supplemental Issue of 34th US Symposium on Rock Mechanics, University of Wisconsin, 1993
   Significance: Computer modeling of ground failure by aging.
6. Mine Application Example
   "Long-Term Evaluation of Stress Control Method of Underground Mining at Sifto Salt Mine"
   Authors: Donald Dickie & Shosei Serata
   Source: Journal of Mining Engineering, January 1993
   Significance: Demonstrating how to convert a failing mine to supreme producer
7. Coal Mine Application
   "Stress Control Method applied to Stabilization of Underground Coal Mine Openings"
   Authors: Serata, S., Carr, F. and Marin, E
   Source: Proc. 25th U.S. Symposium on Rock Mechanics, Northwestern University, 1984, pp 583~590
   Significance: Successful application of stress control method to deep coal mining

8. Application to hard Rock Mining
   "In-Situ Stress Measurements in Stratified Hard rock Formation"
   Authors: Shrinivasan, K. and Serata, S.
   Source: 26th U.S. Symposium on Rock Mechanics, Rapid City, South Dakota, 1985 Pp 1227~1234
   Significance: Demonstrating stress control in hard rock mining
9. Application to Long-Wall Mining of Coal
   "Recent Advancement of Stress control Method"
   Authors: Serata, S., Fuenkajorn, K.
   Source: Proceeding of International Conference on Long-Wall, Pittsburgh, PA. 1991, pp 265~283
   Significance: Application of stress control to long-wall mining.
10. Numerical Analysis based on Stress Measurement
   "Numerical Solution of Strain softening and Dilation of Rock Salt"
   Authors: Fuenkajorn, K., and Serata, S.
   Source: International Journal of Rock Mechanics and Mining Science, Supplemental Issue of 34th Symposium on Rock Mechanics, University of Wisconsin, 1993
   Significance: Numerical optimization of salt mining by stress control.
11. In-Situ Stress Measurement
   "Development of In-Situ Stress State Measurement Method using Single-Fracture Method"
   Authors: Uno, H., Katayama, I., Shingu, K., Serata, S. and Aoki, K.
   Source: Proceedings of the Japan Symposium on Rock Mechanics, 10, 1998 pp 659~664
   Significance: Invention of force balance principle for stress measurement.