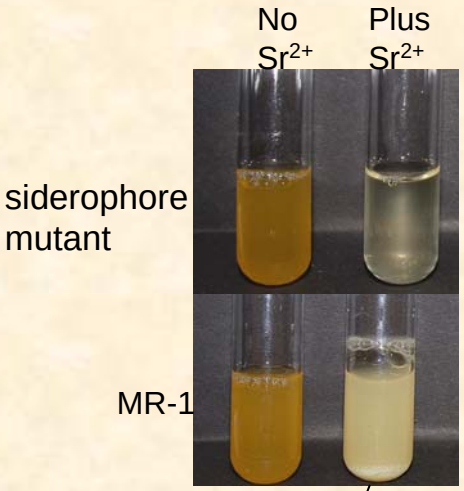
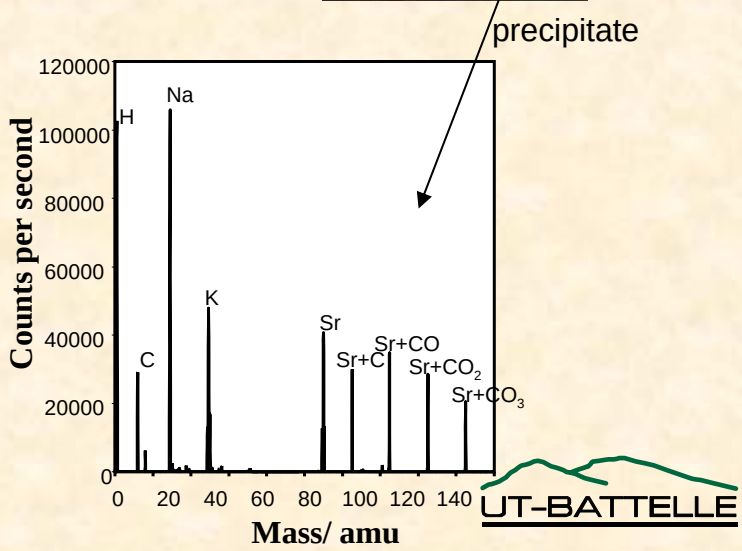
# The response of *Shewanella oneidensis* to strontium stress suggests link between iron metabolism and microbe-mediated metal precipitation

Contact: Dr. Steven Brown, brownsd@ornl.gov, (865) 576-2368
Dr. Dorothea Thompson, dthomps@purdue.edu, (765) 496-8301

- **Strontium is found at the NABIR FRC site in sediment and groundwater at levels up to 512 mg/kg and 3.3 mg/l, respectively.**
- **We examined the physiology and gene expression dynamics of *Shewanella oneidensis* MR-1 in response to strontium (Sr) exposure.**
- **Siderophore (compounds that associate with metals) biosynthesis genes and iron transport were among those most highly induced in response to acute 180mM $SrCl_2$ stress and provided inference into the physiological status of the bacteria.**
- **MR-1 was found to be highly resistant to $Sr^{2+}$ and to promote the precipitation of Sr.**
- **Mutant studies indicated that Sr precipitation was apparently dependent on siderophore production.**
- **A greater understanding of bacterial resistance to metal toxicity and microbe-mediated metal precipitation mechanisms may provide novel strategies for effective metal immobilization in the environment.**




OAK RIDGE NATIONAL LABORATORY
U. S. DEPARTMENT OF ENERGY

UT-BATTELLE

# Cellular Response of *Shewanella oneidensis* to Strontium Stress

**Contact: Steven Brown, *brownsd@ornl.gov*, 865-576-2368**
**Dorothea Thompson, *dthomps@purdue.edu*, 765-496-8301**

**DOE/Office of Science/Biological & Environmental Research**

The physiology and transcriptome dynamics of the metal ion-reducing bacterium *Shewanella oneidensis* strain MR-1 in response to nonradioactive strontium (Sr) exposure were investigated. Studies indicated that MR-1 was able to grow aerobically in complex medium in the presence of 180 mM $SrCl_2$ but showed severe growth inhibition at levels above that concentration. Temporal gene expression profiles were generated from aerobically grown, mid-exponential-phase MR-1 cells shocked with 180 mM $SrCl_2$ and analyzed for significant differences in mRNA abundance with reference to data for nonstressed MR-1 cells. Genes with annotated functions in siderophore biosynthesis and iron transport were among the most highly induced (>100-fold [$P < 0.05$]) open reading frames in response to acute Sr stress, and a mutant (SO3032::pKNOCK) defective in siderophore production was found to be hypersensitive to SrCl2 exposure, compared to parental and wild-type strains. Transcripts encoding multidrug and heavy metal efflux pumps, proteins involved in osmotic adaptation, sulfate ABC transporters, and assimilative sulfur metabolism enzymes also were differentially expressed following Sr exposure but at levels that were several orders of magnitude lower than those for iron transport genes. Precipitate formation was observed during aerobic growth of MR-1 in broth cultures amended with 50, 100, or 150 mM $SrCl_2$ but not in cultures of the SO3032::pKNOCK mutant or in the abiotic control. Chemical analysis of this precipitate using laser-induced breakdown spectroscopy and static secondary ion mass spectrometry indicated extracellular solid-phase sequestration of Sr, with at least a portion of the heavy metal associated with carbonate phases.

**S. D. Brown**, M. Martin, S. Deshpande, S. Seal, K. Huang, E. Alm, Y. Yang, L. Wu, T. Yan, X. Liu, A. Arkin J. Zhou, **D. K. Thompson**. Cellular Response of *Shewanella oneidensis* to Strontium Stress. 2006. Appl. Environ. Microbiol. 72(1): p. 890–900.