Solution to PE Exam Question #10

$$E_{\text{cell}}^{\circ} = E_R^{\circ} - E_L^{\circ}$$

$$E_R^{\circ} = +.401 \text{ V}_{\text{SHE}} \text{ for; } 2\text{H}_2\text{O} + \text{O}_2 + 4\text{e} \rightarrow 4\text{OH}^-$$

$$E_L^{\circ} = -.828 \text{ V}_{\text{SHE}} \text{ for; } 4\text{H}_2\text{O} + 4\text{e} \rightarrow 2\text{H}_2 + 4\text{OH}^-$$

Cell reaction:

half cell reactions

overall cell reaction

$$E_{\text{cell}}^{\circ} = +.401 - (-.828) = 1.228 \text{ V}_{\text{SHE}} \text{ at all pH's including pH} = 10$$

On the Pourbaix diagram at 298°K, 1 atm.

$$E^{\circ} = 1.228 - .059 \text{ pH} \quad \text{for the oxygen evolution line}$$

$$E^{\circ} = 0 - .059 \text{ pH} \quad \text{for the hydrogen evolution line}$$

Therefore, subtracting shows that EMF is independent of pH.

Prospecting With Soil Bacteria

Nancy Parduhn

Preliminary studies by John R. Watterson and others at the U.S. Department of the Interior Geological Survey in Denver indicate that a prevalent soil bacterium, *Bacillus cereus* can help locate metallic mineral deposits. The *B. cereus*, a penicillin-resistant soil micro-organism, is found in above-background concentrations in soils and sediments associated with mineral deposits of Au, Ag, Mo, Bi As, and Cu. This phenomenon results because large numbers of metal tolerant, penicillin-producing molds occur in metalliferous soils where penicillin hydrolyzes to a powerful metal-chelating agent, penicillamine. This agent helps protect molds from toxic metals, giving them an advantage over non-penicillin-producing molds. While most bacillus soil bacteria strains are quite sensitive to penicillin, the *B. cereus* is both metal-tolerant and penicillin-tolerant, and therefore prevails over other species in metal-stressed soils.

The Department of the Interior study measured *B. cereus* content in surface soils and mineralization at depth. Two areas were chosen that differ in type of gold deposit and environment. Near Empire, Colorado, veins containing gold, pyrite, chalcopyrite and quartz, within Precambrian Boulder Creek granite are overlain by 15-20 feet of glacial overburden and covered by aspen and pine forest vegetation. Near Elko, Nevada, an un-

developed disseminated epithermal gold deposit within silty limestone, is overlain by an unknown amount of transported overburden and covered with cold-desert sage brush vegetation. Geochemical analysis of surface soils from the Empire region poorly reflects the known distribution of gold veins in the bed rock. However, geomicrobial exploration of these surface soils using the *B. cereus* assay proved significant diagnostic value. Measurements of *B. cereus* counts in the Nevada desert soil samples were lower than in the Colorado forest sample. In both cases, *B. cereus* counts in the mineralized areas are an order of magnitude greater than background counts. Other studies of stream sediment from the Gunnison National Forest in Colorado show a strong correlation between *B. cereus* distribution and geochemical indicators of gold and silver mineralization (hydromorphically deposited bismuth and arsenic on stream sediment oxide coatings).

In general, the low density and small size of bacterial spores enable them to travel much farther from their source than heavy mineral grains, making them effective in locating mineral deposits in glacial covered terrain where geochemical techniques are ineffective. Microbial prospecting may become a very competitive prospecting technique due to the rapid, inexpensive surface sampling and apparent reliability.

Correction

The January 1985 issue of *Journal of Metals* (Volume 37, Number 1) features an incorrect figure on page 57. Due to an editorial miscue, the wrong illustration appears as Figure 12 in the article "Experimental Characterization of Fatigue Crack Tip Processes" by J. Lankford and G.R. Leverant. While the text references and caption are correct, the following figure should have instead appeared with the corresponding figure reference. The figure appearing in the January issue should not have been included. We regret any inconvenience our error may have caused either of Drs. Lankford or Leverant and would like to take this opportunity to apologize and set the record straight.

Text references from the section "Experimentally Observed Fatigue Crack Tip Behavior:" The results of the SCOD measurements in Figure 12 illustrate that stress in excess of 300 MPa was required to open the crack in the as-peened condition. After a stress relief heat treatment, the identical crack started to open at a stress ≤ 50 MPa. The reduction in effective stress intensity range resulting from the compressive stress can be calculated using a boundary integral approach.¹⁶ The calculated SCOD's, using the effective stress intensity range, are compared with the experiment in Figure 12."

Figure 12. Comparison of observed and predicted SCOD vs. load behavior for corner-cracked Ti-6Al-4V specimen.