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QUARTERLY PROGRESS REPORT

January 1, 1980 to April 22, 1980

"In-Situ Stress Determination Based on Fracture Response Associated with Coring Operations"

Contract No. DE-AT21-79MC11284, Task No. 17

## Introduction:

This is the Second Quarterly Progress Report of Contract No. DE-AT21-79MC11284. The general objective of this research is to investigate the induced fractures at great depths due to in-situ stress relief during coring operations. Also, a methodology will be developed to determine the magnitudes of horizontal in-situ stresses with the help of the results obtained from the abovementioned study. Herein, the induced core fracture patterns (originally identified by C. S. Dean of METC) observed in Devonian Shales are being studied to correlate the fractures and the magnitudes of stresses.

## Task 2.1.1.- Summary of Progress:

Work has continued during this quarter to find the mechanical properties such as compressive strength, young's modulus, poisson's ratio and split cylinder strength.

## Specimen Preparations:

In general, the maximum specimen dimensions of any core sample obtained from Cliff Mineral Inc. are 3-1/2" in diameter and 7" in length. In this report, this will be referred to as 3-1/2" X 7-1/2" specimens. Samples with lengths greater than 7" displayed undue curvature and undulations along the core length; hence, unacceptable for accurate testing and evaluation for the results.

Therefore, 2" X 4" samples were cut from the parent cores, with the aid of Rock Well Delta Cutters. Herein, the spindle was rotated at 200 rpm with 0.002" feed. The core samples for our testing were made by drilling them from the parent cores, which are free of cracks and voids to the naked eye. After the cores are sawed, the end tolerances, i.e., least count of 0.001" are achieved by polishing the core.

Split Cylinder Tests (Brazilian tests):

This test is conducted to find the tensile resistance of the core subjected to the uniform line loading along the longitudinal axis of the specimen.

Procedure:

The carefully prepared core sample is positioned along its longitudinal axis and tested under compression by inducing tensile stresses perpendicular to the plane of the loading. The specimen is loaded at a rate of $1 \times 10^{-5}$ in/in/sec.

Failure Pattern:

The two types of failures have been observed during the testing: (1) Diametrical (failure along the longitudinal axis of the specimens); and (2) Discing. Both these failures are attributed to tensions in the directions perpendicular to their failure planes.

Test Conditions:

It should be noted that the surface roughness and moisture content of the Specimen will have certain bearing on the results; however, they will be properly accounted for at a later date.

Tests for Compressions, Poisson's Ratio and Young's Modulus:

This test is conducted to find the load resisting ability and also the stress-strain behavior of cores subjected to uniaxial compression.

Procedure:

Four strain gages (gage length of .64 and gage factor 2) are mounted. approximately at mid height of carefully prepared specimens to measure average axial and diametrical strains. The specimens are loaded at a rate of $1 \times 10^{-5}$ in/in/sec as the deformation rate provides more information in the non-linear deformation regions of the core subjected to uniaxial compression.

Failure Pattern:

Two types of failure have been observed during the testing: (1) conical failure and (2) Discing. Conical failure attributed to compression, and discing attributed to tension where developed in the planes perpendicular to the plane of applied loading.

Test Conditions:

Several test conditions that pronouncedly effect the test results are noted and listed below:

(1) Dimensional tolerances, the L/D ratio, end inclination and the surface roughness

(2) Moisture content

(3) Deformation rate, and

(4) Specimen end lubrication.

Some of these conditions are accurately controlled and others will be properly accounted for at a later date.

Observations:

The parent core obtained from Cliff Mineral Inc., has microcracks. These microcracks are circumferential in nature, hence it is difficult and time consuming to prepare specimens of required length. The crack may be attributed to material inhomogeneity, stress relief, and weakness in bending along the depth.

Task 2.1.2. Finite Element Model Evaluations:

We are currently evaluating the existing finite element formulations with crack tip elements for future incorporation into one of the canned codes. Also, a separate finite element code for plane strain models with orthotropic material properties and crack tip effects are being developed. However, the progress in this area is slow.