WM2014 Conference, March 2 – 6, 2014, Phoenix, Arizona, USA

A Trial of 4D Cross-Borehole Electrical Resistivity Tomography (ERT) for Detecting and Monitoring Subsurface Leakage and Contaminant Transport, Supporting the Decommissioning of Legacy Silos at the Sellafield Site, UK – 14161

Oliver Kuras *, Paul Wilkinson *, Phil Meldrum *, Lucy Oxby *, Sebastian Uhlemann *, Jonathan Chambers *, Andrew Binley **, James Graham ***, Gareth Dewey ****, Nick Atherton ****
* British Geological Survey
** Lancaster Environment Centre
*** National Nuclear Laboratory
**** Sellafield Ltd

ABSTRACT

A full-scale field trial of electrical resistivity tomography (ERT) technology has been undertaken in a controlled experiment at the Magnox Swarf Storage Silos (MSSS), part of the legacy ponds and silos at the Sellafield Site in Cumbria, UK. The trial constitutes the first application of ERT monitoring at a UK nuclear licensed site. Full 4D ERT processing provided images of resistivity changes occurring since a baseline date, which have revealed likely pathways of silo liquor simulant flow in the vadose zone and upper groundwater system. These pathways were found to be compatible with historic contamination detected in sediment cores retrieved from the trial boreholes. The ERT results have enhanced our conceptualization of likely leak behavior and contaminant transport in the shallow subsurface at the MSSS.

INTRODUCTION

A strategic priority for the UK's Nuclear Decommissioning Authority (NDA) is the reduction of risk and hazard across its estate of nuclear facilities. Legacy ponds and silos at the Sellafield Site in Cumbria, UK, pose the most significant technical challenges in this context. The safe emptying and decommissioning of the MSSS is one of the flagship projects that Sellafield Ltd (SL) is currently undertaking on behalf of the NDA. The uniqueness of the MSSS facility and its location in a complex industrial environment require the use of innovative decommissioning and monitoring technologies both to prepare and to execute the retrievals. The current strategy is for Silo Emptying Plant machines to be installed within the MSSS, which will then be used to retrieve wastes from the silo compartments, thus enabling safe transfer, immobilization and long-term intermediate storage in a modern containment facility.

Leakage of radioactive liquor from the MSSS to ground occurred during the 1970s. While none has been measured since, there is an increased risk that new leakage from the MSSS may occur during waste retrievals. To demonstrate control of silo liquor under normal and abnormal conditions the Ground Environment Management Scheme (GEMS) study was instigated by SL [1]. A key component of GEMS is environmental monitoring to assess the impact (groundwater contamination and risk to offsite receptors) of contaminants that are thought to have leaked to ground in the past and those that could potentially leak to ground during retrievals operations, thus ensuring regulatory compliance.

Scoping studies [2, 3] have identified ERT as the best available technology (BAT) for in-ground detection and volumetric monitoring of potential leakage from the silo foundations within the