

# Study on the Application of Ground Deformation Monitoring Technologies towards Preserving the Natural Resources Infrastructure's Potential in Saudi Arabia



*KACST-JCCP 1st Joint International Workshop for the Earth's Surface and Subsurface 4D Monitoring*

JCCP and King Abdulaziz City for Science & Technology (KACST) implemented a study on Application of Ground Deformation Monitoring Technologies towards Preserving the Natural Resources Infrastructure's Potential in Saudi Arabia over a period of four years, from fiscal 2009 to 2012.

## 1. Background

In Saudi Arabia's oil fields, ground subsidence is occurring as a result of changes in the subsurface structure brought about by many years of crude oil production and injection of seawater, thereby raising concerns about the impact of ground subsidence and induced earthquakes on refineries, pipelines and other oil facilities.

In response to this situation, the study was implemented to preserve the potential of oil-related infrastructures in Saudi Arabia by detecting any impact of ground subsidence and induced earthquakes in advance. More specifically, the study aimed to examine the feasibility of risk management using induced earthquake analysis

technology and active earthquake exploration technology to monitor changes in the subsurface structure.

## 2. Overview

- 1) Implementation period: April 1, 2009 – March 31, 2013 (four years)
- 2) Overseas counterpart: King Abdulaziz City for Science and Technology (KACST)
- 3) Participating companies: NTT Data CCS Corporation
- 4) Activities: The following activities were implemented through a joint effort between JCCP and KACST based on the main theme of establishing ground deformation monitoring technologies by applying the ACROSS continuous seismic monitoring system (accurately controlled routine-operated signal system) and analysis technology. Developed in Japan, the ACROSS system uses accurate sinusoidal waves to monitor seismic motion, and has been applied to various studies in the earth sciences field.
  - Analysis of induced earthquakes
  - Development of seismic analysis tools

- Installation and operation of seismometers
- Training in seismic analysis
- Installation and operation of the ACROSS system and analysis of the data obtained
- Monitoring of ground deformation in oil fields
- Technical examination of the integrated analysis of ground subsidence and seismic analysis

### 3. Observations

In the study, the ACROSS seismic source was applied to geophysical exploration, and a test was performed to monitor ground deformation using its high reproducibility. Additionally, an air injection test was performed in Awaji Island, in which the location of air spaces and their movement were successfully assessed by injecting air into the strata. Furthermore, a monitoring test was performed at a water pumping field in Saudi Arabia, with results indicating that time-lapse changes in the locations of the water table could be monitored over time.

In January 2012, KACST and JCCP held the 1st Joint International Workshop for the Earth's Surface

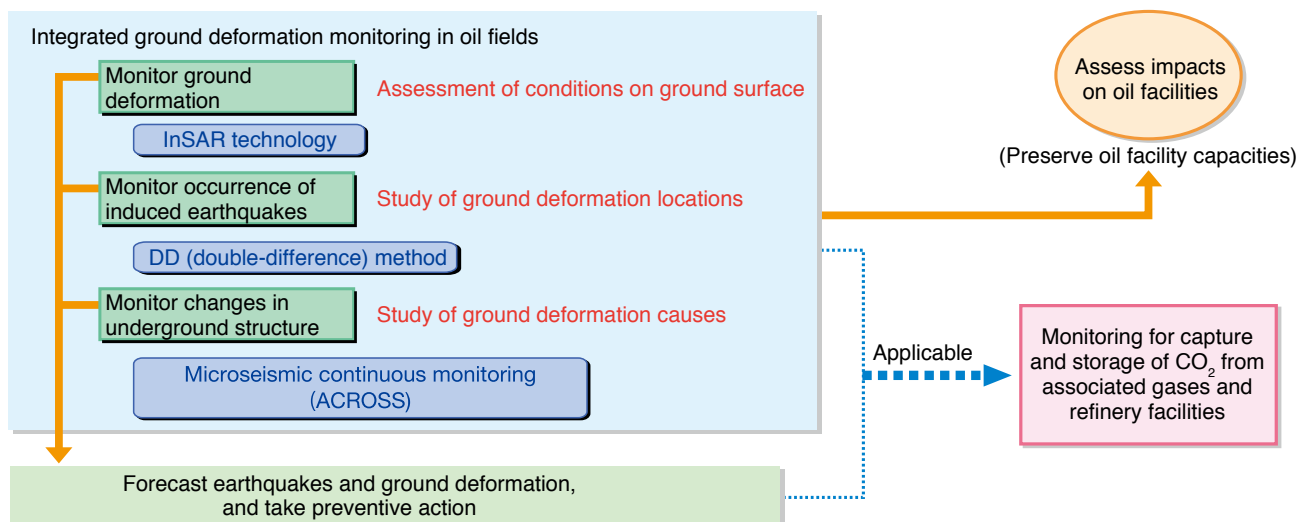
and Subsurface 4D Monitoring at KACST in Riyadh. Attended by experts related to surface and subsurface deformation monitoring and resource exploration and as many as 300 visitors, the workshop captured the strong attention of geophysics experts to the ACROSS system and its analysis method.

The ground deformation monitoring technologies deliver an extremely high level of reproducibility, and are suited to hourly monitoring of subsurface changes in such places as oil and natural gas reservoirs and CO<sub>2</sub> underground storage. For this reason, the technologies are also garnering strong attention for their potential to contribute to carbon capture and storage (CCS), which has become a focus of widespread attention as a core technology for environmental conservation, by monitoring storage conditions before CO<sub>2</sub> generated from oilfield-produced gas and oil refining facilities could be stored in underground sealed layers. A demonstration test of the results of the study will be launched as a new project next fiscal year.

JCCP hopes to further deepen ties between Saudi Arabia and Japan in the future through technical cooperation such as this study.

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Ground deformation monitoring technologies



Source: NTT Data CCS Corporation