

Workshop Reports

Core-Log-Seismic Integration – New Scientific and Technological Challenges

“Core-Log-Seismic Integration: New Scientific and Technological Challenges,” a technical workshop addressing critical issues in scientific drilling and coring was held in Tokyo, Japan on October 3-4, 2005. The workshop was organized by the Center for Deep Earth Exploration - Japan Agency for Marine-Earth Science and Technology (CDEX-JAMSTEC) and the Japan Drilling Earth-Science Consortium (J-DESC) following an initiative discussed during the February 2005 IODP Scientific Measurements Panel (SciMP) meeting.

An aim of this workshop was to promote discussions between two main groups of scientists, those who use core, log and seismic data to address academic or industrial problems and those who are developing new databases, data handling procedures, and visualization technologies. Goals of the workshop included reviewing and exploring extant methods for processing and analysis of core, log and seismic data with significance placed upon problem solving using a variety of methodologies and approaches to core-log-seismic integration. Special emphases were placed on recognizing the interdependence between problems addressed and the technology/methodology used for data collection, analysis, integration and promotion of core-log-seismic integration as an important focus within the drilling science community. To these ends, 40 scientists attended 17 high-quality talks (6 from US, 6 from Japan, 4 from Europe and 1 from Taiwan). The topics discussed included: (1) the different approaches to core-log and core-log-seismic integration from theoretical (scaling problems, modeling, petrophysics) or technological (engineering, IT) points of view, (2) the possibilities for testing these methods using individual case-studies (including marine, coastal and continental environments), and most importantly, (3) comparison and exchange of methods and views between researchers working in related or complementary fields. Numerous exchanges of knowledge and experience regarding both standard and newly developed practices and methods clearly underlined the benefits of such workshops. Benefits that are both for scientists and science itself due to the identification of new technological and methodological avenues for development of innovative solutions to long-standing scientific and technological challenges. The workshop program, proceedings and most of the presentations can be accessed at :

http://www.jamstec.go.jp/chikyu/jp/news/nw_050712.html.

Major discussion items are summarized below.

Information Exchange: Terminology, Units, Tools, Methods, Assumptions

Because core-log-seismic-integration methodology and practice is intrinsically sited at the interface between multiple scientific and technical fields of inquiry, a major effort is needed to: (1) promote better documentation of methods, assumptions, tools, resolution, and limitations inherent in each newly acquired data set, and (2) better address problems associated with parallel measurements acquired at different scales or resolution, often using different equipment or tools, and/or relying on different principles/assumptions. A clear example of potential problems associated with these kinds of overlaps is the measurement of “porosity”. Porosity can be measured or derived from discrete samples (moisture and density measurement vs. Hg or BET porosities), neutron-porosity logs, density logs, resistivity logs and/or analysis of downhole imagery, and all reported in any database as “porosity,” in the

same units; however, these measurements of “porosity” can have vastly different values depending on methodology, even within the same core interval.

In collaboration with industry, a project has been initiated to set up a working group that will propose discipline-wide descriptive terminology for standard measurement techniques and results. Any contributions and participation in this working group are greatly welcomed. If successful, accepted by the scientific community, and adopted or supported by the relevant scientific programs and investigative initiatives, this terminology will be disseminated in the form of a series of manuals. This manuals will include documentation of the many potential quality assurance and quality control caveats.

Depth Issues

A critical issue in core-log integration is the question of standardizing depth positioning and depth accuracy of collected data sets; this issue generated extensive discussion and debate. Participants clearly identified the need for standard definitions and processing procedures for generating depth scales for the geological and geophysical aspects of drilling, coring and logging.

- Geological measurements, including cores, cuttings, and gas/mud logging operations, must be calibrated accurately and efficiently. Specifically, conversion of incident time (for mud logging, cuttings, and gas logging data) and conversion of curation depth (for cores and samples) must be undertaken to derive accurate and internally consistent depth values.

- Geophysical measurements, including logging (wireline and logging while drilling) and seismic (vertical seismic profiling, seismic while drilling, and regional 2-D and 3-D seismic surveys) data must be converted from either rig-floor depth or seismic two-way traveltimes into the final depth reference frame. At the workshop, as it is in industry, the role of Vertical Seismic Profiles (VSP) in seismic calibration of depth scales was widely emphasized, and led to discussions of:
 - receiver technology (i.e. frequency range),
 - nature of the source (e.g.. borehole, seafloor, sea-level, air gun, vibration, explosion),
 - coupling between formation and seismic tool in complex environments,
 - the role of offset VSPs and multi-component tools in investigation of S-waves and acoustic/seismic anisotropy.

Both discussions gave rise to a series of complementary proposals for depth processing procedures dependent on data type and quality. The consensus recommendations reached during this workshop are currently being summarized and will be submitted to an IODP-ICDP depth processing working group for evaluation and further discussion.

New Technology: Initiatives and Needs

Presentations and discussions of new technological developments and challenges focused on depth issues, data acquisition in extreme environments and integration of a wide array of new data types and formats. Examples of such developments included intensive feasibility testing

of logging while coring systems potentially equipped with geophones (for check-shot surveys while coring), and development of new downhole probes for microbiology and geochemical investigations in order to meet the scientific needs to investigate the deep biosphere.

Additional discussion focused on the problem of in situ conditions versus laboratory core or sample measurements, with respect to core-log-seismic integration. Challenges arose regarding the differences between, for example, acoustic properties (e.g. P- and S-wave velocities, Q factor values, anisotropy) determined from sample or core measurement as opposed to downhole (i.e. in situ) seismic velocity or attenuation values.

Recommendations were devised for a review of available equipment and expertise (specifications vs. needs), and adoption of an optimal strategy (selection of samples, on site vs. delayed investigations) depending on scientific objectives.

Proposal for a Natural Laboratory or Test Site

Finally, after two days of intensive discussion, a competence network for consultation, feedback, advice and interaction was put in place. Cooperative initiatives and collaborative projects that grew naturally out of the workshop discussions gave rise to the following proposal: *Dedicate one or several well-characterized test site(s) encompassing a wide variety of geological settings for educational and methodological uses. At such a site(s), experiments, methods and tools could be calibrated and tested, providing references for further study, and a basis for continued progress.*

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