SCAL Designer – an interactive software package

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SCAL (special core analysis) Designer is the first element of a modular interactive software package called Magellan. When complete Magellan will encompass topics as diverse as PVT, Log Interpretation, Conventional Core Analysis, Formation Damage and Reservoir Modelling. The purpose of each module is to afford the user the opportunity to combine training and reference with programme design. The target audience is all encompassing, from the inexperienced to the seasoned professional. Each may extract pertinent information whenever there is a requirement to clarify an uncertainty in an unfamiliar area.

SCAL Designer has been created around a two-tier framework that will be common to many of the Magellan modules. The first tier is termed the Guru and encompasses those topics judged to be necessary to achieve an understanding of the particular subject. At the core of the second tier, known as Designer, is a series of interlocking truth tables driven by information panels completed by the user.

The Guru is divided into 15 sections, of which 13 are focused on specific test groupings, e.g. wettability and relative permeability. The remaining sections provide a comprehensive bibliography and an example SCAL report as might be delivered by a commercial laboratory.

Figure 1. Screen Images from the SCAL Guru

Within each of the test groupings are eight subsections that deal with specific aspects of the subject. Using a combination of text, diagrams, equations and worked laboratory examples the measurement formats are explored. Their input to petrophysical and reservoir engineering applications is identified and the theoretical background is presented in a straightforward manner. By way of further illustrating the laboratory functions of SCAL video clips are to be found in the ninth subsection.

The Guru can be navigated via the dropdown menus in one window, while the selected items appear in an adjacent window. Access can be gained either in isolation if the module is being used as a training aid, or as an aide-mémoire when running the designer element of the software.

The Designer tier provides the user with the tools necessary to design a SCAL preparation and analytical programme that is fit for purpose. The aforementioned truth tables encompass reservoir type, reservoir lithologies, project objectives and executed downhole logs, and operate within a Wizard function. The highlighting of appropriate items on panels that interface with the tables drives an elimination and selection process that suggests a suitable agenda. The generation of the programme can be automatic, once key data points are completed, with in-built defaults providing the preferred measurement sequence and number of samples. Alternatively there are opportunities to input personal or company preferences that control and shape the final programme.

Figure 2. Screen Images from the SCAL Designer

The programme generated by the Design Wizard can in turn be validated by the Report Wizard. The validation is in two parts: flagged lithologies and required parameter generation. For each lithology a number of flags are presented, which inform the user of areas of concern that must be addressed. For example, in unconsolidated sands hysteresis linked to the repeated use of an elevated overburden pressure must be avoided by following the multiple sample suite approach described in the sample preparation component of SCAL Guru.

Table 1

Flagged Lithology – Unconsolidated Sand

- **Core Condition.** The user should be aware that the core must have been stabilized at wellsite by one of the three commercially available methods, i.e. resin, foam or gypsum. Alternatively the core may have been frozen to prevent slumping, fracturing, etc. However, this method can disrupt grain to grain relationships, due to the expansion of the pore fluids. Without physical support, changes to the pore system can prevent the generation of representative data.
- **Pre-Screening.** Prior to cutting the liner for geological examination and the selection of sampling points, the use of CT Scanning is recommended. Bedding and other structural features can be identified, rubble sections, void spaces and artefacts such as pyrite nodules avoided, and slumping, fracturing and localized collapse accounted for.
- **Sample Size.** The lack of adequate cementation generally limits the size of the samples to be tested to plugs of 1 or 1.5 inches in diameter.
- **Sample Mounting.** To provide a right cylinder for testing purposes requires the sand to be plunge cut or rotary drilled (if frozen), and mounted in heat shrink PTFE tubing with a pair of steel gauzes over each end face. A mounted plug can be used for the full range of SCAL testing.
- **Sample Preparation.** As the grains may move or rotate under adverse conditions, the use of the extended flush cleaning regime or the repeated refluxing of a soxhlet extractor can be damaging. It is recommended that the benign Corex Constant Immersion-Constant Replenishment system of cleaning be employed. This technique does not promote liquid flow but cleans through the removal of contaminants by gentle diffusion.
- **Establishment of Base Parameters and Assignment of a Multi Suite System of Testing.** Unconsolidated sand is liable to hysteresis caused by the repeated application of an overburden pressure. It is preferable to measure the base parameters of gas permeability and porosity at a nominal pressure of

no more than 300 psi. Subsequent testing should be performed in a single rotation, where an overburden pressure is required, thereby avoiding numerous repacking cycles. This form of testing requires sufficient core material to be available to allow for multi suite sampling in areas of interest.

- **Measurement Format.** Unconsolidated sand is particularly sensitive to overburden pressure and it is necessary to perform the majority of the appropriate SCAL tests under the effective reservoir confining pressure. By modifying the pore system, values such as capillary pressure, formation factor and residual oil will vary significantly as the effective overburden pressure is increased.
- **Recommended Testing.** In addition to selecting the overburden pressure option for the majority of SCAL tests, the performance of a number of key measurements is recommended. These are as follows:

1. Rock (Pore Volume) Compressibility

2. Porosity and Permeability as a function of overburden pressure

3. Acoustic Velocity, with the calculation of Poisson's ratio, Young's Modulus and Bulk Modulus.

4. Sieve Analysis

Each test provides data for assessing the competence of the rock material to withstand the rigors of production.

The second part of the report wizard provides the user with the means of ensuring that all the test parameters required to satisfy the objectives of the study are present. This ability to check prevents an inappropriate modification from removing an important part of the SCAL programme.

The end product is a detailed tender document containing all the information required by a commercial laboratory to generate a quotation, which may be sent electronically to the user's preferred contractors. A costing option containing typical unit test prices is included to provide a preliminary indication of the financial implication of particular test format selections. On receipt of the contractors' bids, a spreadsheet can be generated to allow comparison of the unit and overall prices. The Report Wizard also produces an approval for expenditure document if it required for programme sanction.

Figure 3. Screen Image from the SCAL Designer Report Generator

Phase two of SCAL Designer is currently underway and will include various SCAL data handling routines and a module to import Conventional Core Analysis data and select SCAL samples. Other Magellan modules outside the field of Special Core Analysis are in planning.

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