Noted rock physicist is 2010 Distinguished Short Course Instructor

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When Colin Sayers emerged as a candidate to lead the SEG/EAGE Distinguished Instructor Short Course (DISC) for 2010, Tad Smith, manager, seismic analysis for ConocoPhillips and the DISC committee chairman, did not hesitate. Said Smith, "I've been following Colin's work and reading his papers (and attending his talks) long before I ever met him. His work is some of the best in the literature.

"I've also heard Colin give technical presentations numerous times. He always delivers a clear, coherent, and well organized talk, and does an outstanding job of keeping the audience interested in his message. He also has a unique ability to present complex material in a manner that is relevant and interesting to many different levels of expertise. He is an outstanding and engaging speaker, and will no doubt give one of the best DISCs yet," concluded Smith.

A name virtually synonymous with rock physics, Sayers has been practicing in the field for 25 years. He currently is scientific advisor for Schlumberger's Data and Consulting Services Geomechanics Group in Houston where he provides consultancy in geophysics, rock physics, drilling and reservoir geomechanics and the characterization of fractured reservoirs. Sayers entered the oil industry as a member of Shell's exploration and production laboratory in Rijswijk, The Netherlands in 1986, moving to Schlumberger in 1991.

SEG/EAGE 2010 DISC instructor Colin Sayers

In addition to geophysics and rock physics, Sayers' expertise extends to drilling and reservoir geomechanics, pore pressure prediction, wellbore stability analysis, analysis of production-induced reservoir stress changes, subsidence, fault reactivation, 3D mechanical Earth modeling, sanding, fractured reservoir evaluation, borehole/seismic integration, stress-dependent acoustics, advanced sonic logging, AVAZ, and fluid flow in fractured reservoirs.

Sayers is a member of the AGU, EAGE, SEG, and SPE; a member of SEG's Research Committee; and a member of the editorial board of the *International Journal of Rock Mechanics and Mining Science*. Sayers also is serving as Editorial Board Chairman for *THE LEADING EDGE*. He has a BA in physics from the University of Lancaster, U.K.; a DIC in mathematical physics; and a PhD in physics from Imperial College, London, U.K. He has published numerous papers and holds several patents in the areas covered by this course.

Sayers recently discussed the upcoming DISC course and why rock physics is such a timely subject for the course today.

You're such a renowned figure in the field, and you're very much in demand these days. What made you agree to do the DISC course, which, as everyone knows, is quite an extensive undertaking?

I accepted because it was an opportunity to present an interesting and important multidisciplinary topic to a diverse international audience. The state of stress within the Earth has a profound effect on the propagation of seismic and borehole acoustic waves, and this leads to many important applications of elastic waves for solving problems in petroleum geomechanics.

These problems are best addressed by the construction of a mechanical Earth model that allows information relating to the geological structure, mechanical stratigraphy, pore pressure, in-situ stress state, rock mechanical properties, and failure mechanisms to be captured and used to predict the response of the Earth to the changes in stress imposed by drilling and production. The building of such models is a multidisciplinary activity that requires input from people with expertise in geophysics, geology, geomechanics, rock physics, petrophysics, drilling engineering, well engineering, reservoir engineering, etc.

Because of the multidisciplinary nature of the subject, each person brings a new perspective, and I am particularly interested in hearing the opinions and questions of the attendees. As an employee of an oilfield services company, one of the most important tasks is to listen to and understand the challenges of those working in the oil and gas industry, and I am greatly looking forward to these discussions. I also enjoy teaching, and am looking forward to visiting the many cities chosen by the SEG and EAGE for this course, and to meeting the people who will attend.

Geomechanics is certainly one of the "hot" topics in the oil industry, specifically the use of rock physics to solve geomechanical challenges. Why are pore pressure, in-situ stress and geomechanical properties so important?

Geomechanics deals with the prediction and management of rock deformation and failure. Geomechanical problems resulting from the change of stress in the rock induced by drilling and production make many hydrocarbon

production projects challenging. Some of the challenges include wellbore stability and formation fracture during drilling, as well as problems from reservoir stress changes that occur during production such as reservoir compaction, surface subsidence, casing deformation and failure, sanding, reactivation of faults, and bedding parallel slip. Also, if the pressure in the wellbore during drilling drops below the pore pressure in the formation, then a kick or blowout may occur, while if the wellbore pressure exceeds the minimum in-situ stress, then loss of drilling fluid may result.

The failure of rocks depends on their geomechanical properties and on the stress acting on the rock, so knowledge of these properties is essential in well design and hydrocarbon production planning. Seismic and borehole acoustic waves are particularly helpful for determining the pore pressure, in-situ stress and geomechanical properties, and this leads to many important applications of elastic waves for solving problems in petroleum geomechanics.

You are renowned for your expertise in rock physics. How long have you been involved with it? What is it that excites you about it?

I have a wide interest in the physics of complex media, which goes back at least as far as the time I was working for my PhD. in theoretical solid state physics at Imperial College, London. In 1978, I moved from Imperial College to the Materials Physics Division of the Atomic Energy Research Establishment, Harwell, where I first began to work on elastic wave propagation in complex media. This work focused on characterizing the microstructure and stress state of materials using the velocity and attenuation of ultrasonic waves and is directly related to methods I am using today to characterize the structure and stress state of sedimentary rocks using seismic and borehole acoustic waves.

My first serious encounter with sedimentary rocks was in 1986 when I joined Shell's Exploration and Production Laboratory in Rijswijk, The Netherlands. Sedimentary rocks are particularly interesting examples of complex media, having structures on a wide variety of length scales and processes that operate on a wide variety of time scales.

Einstein has been quoted as saying that a theory should be as simple as possible, but no simpler, and this is particularly true in rock physics. Sedimentary rocks present many types of complexity, and the challenge is to identify and model those that are essential to understanding the properties of rocks so that we can make appropriate predictions.

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What is the next wave of research in geomechanics?

My interest is in chipping away at the important problems rather than in riding the next wave in research. One of those problems is related to the issue of complexity. There is currently much important work being done on understanding the behavior of sedimentary rocks at the microscale. However, sedimentary basins contain features on a wide variety of length scales from the size of grains and microcracks to fractures, bedding, flow channels and faults.

One example I will discuss in the course is the compliance of a fracture which varies strongly with fracture size, with the result that large fractures have a much greater effect on elastic wave propagation than do grain boundaries and microcracks. A major challenge is to develop methods of upscaling from the pore-to-reservoir scale that include the effects of compliant stress-sensitive features such as fractures and faults that may dominate the large scale response of the reservoir and surrounding rocks.

Another important challenge I will address is the treatment of uncertainty. The building of a 3D mechanical Earth model requires the integration of data from many subsurface disciplines, and this requires an understanding of the uncertainty in the different types of data. As one example, drilling engineers require an estimate of formation pore pressure so that they can design the mud weight and casing string to avoid kicks and blowouts while drilling the well.

Currently, a seismic velocity to pore pressure transform is often applied with no quantification of uncertainty. This means that expensive drilling decisions are often made without adequate risk assessment. A better approach is to recognize the uncertainty in the prediction and to continually update the model using data acquired while the well is being drilled so that the best possible prediction with reduced uncertainty is continually provided ahead of the bit. This is one objective of real-time geomechanics, and several examples will be given in the course.

The course is described as "integrated for all disciplines." What do you hope participants will take away from it, be they engineers, geologists, petrophysicists or geophysicists?

The course will give attendees a good understanding of the sensitivity of elastic waves in the Earth to the in-situ stress, pore pressure, and anisotropy of the rock fabric resulting from the depositional and stress history of the rock, as well as increased understanding needed to apply geophysics and rock physics solutions to geomechanical challenges in exploration, drilling and production.

I also hope that people with expertise in different disciplines including geophysics, geology, geomechanics, rock physics, petrophysics, drilling engineering, well engineering, reservoir engineering will attend and remember the course as an occasion where they were able to meet people from different disciplines and to discuss common problems. TLE