

Poroelastic Solutions for Spherical-Tip Indentation

A method for addressing current challenges in characterizing poroelastic materials

This method for characterizing poroelastic materials addresses the mathematical difficulties involved with solving the complex system of equations that need to be accounted for, including the compressibility of both solid and liquid. Georgia Tech's approach advances the promise of using poroelastic indentation with rigid tools as a versatile experimental technique for better understanding the properties of such materials. The method enables researchers to interpret experimental data more readily through use of a spherical indentation tool (either permeable or impermeable) aided by force sensors and processors that direct the tool to indent the material to a predetermined depth and record the force data and elapsed time. The improved characterization technique can potentially improve design protocols for a range of applications in Earth resources engineering, including hydraulic fracturing, reservoir production, geothermal recovery, carbon dioxide storage, and more.

Summary Bullets

- **Robust:** Provides a rigorous theoretical base that takes into account poroelastic coupling and the effects of Poisson's ratio as well as the compressibility of both fluid and solid phases on force relaxation
- **Intelligent:** Can be used with sensors and processors to automatically direct an indentation tool and record pertinent data
- **Flexible:** Accommodates both permeable and impermeable indentation tools

Solution Advantages

- **Robust:** Provides a rigorous theoretical base that takes into account poroelastic coupling and the effects of Poisson's ratio as well as the compressibility of both fluid and solid phases on force relaxation
- **Intelligent:** Can be used with sensors and processors to automatically direct an indentation tool and record pertinent data
- **Flexible:** Accommodates both permeable and impermeable indentation tools
- **Enabling:** Fulfills the promise of material indentation as a valuable experimental and evaluative technique by addressing current characterization challenges

Potential Commercial Applications

- Hydraulic fracturing for oil and gas recovery
- Geotechnical engineering
- Geothermal recovery

- Carbon dioxide storage

Background and More Information

The process of indentation using rigid tools has been widely studied for its versatility as an experimental technique to better understand the properties of poroelastic materials. In particular, spherical indentation has been applied to characterize poroelasticity of fully saturated porous media, such as polymeric gels and hydrated bones, via either displacement- or force-controlled tests. However, challenges with the complexity of the mathematical equations have limited the full realization of these methods. Georgia Tech's method is an improved material characterization technique that takes into account the compressibility of both the fluid and solid phases and extends previous characterization methods to general poroelastic media.

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IP Status

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Publications

[Poroelastic Response of Spherical-tip Indentation](#), 52rd U.S. Rock Mechanics/Geomechanics Symposium - 17-20 June 2018

Images

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