



EXPLORATION

Seismic Imaging & Processing

PRODUCTION

Well Logging

Enhanced Oil Recovery

Flow Assurance

Unconventional Resources

SUPPORTING TECHNOLOGIES

Fluid Properties, Rheology, Molecular Modeling, Materials and Sensors, Robotics, Information Technology

EMERGENT TECHNOLOGIES

Renewable Energy, Energy

Transmission and Storage,

Energy Efficiency

POLICY ISSUES AND ECONOMICS



Flow Assurance at Rice

- ▼ Gas Hydrates
 - Effect of emulsions on hydrate formation and aggregation in oil
 - Water content in natural gas systems
 - Seafloor stability
- ▼ Asphaltenes
 - Developed an accurate molecular model for precipitation
 - Developing a flow simulator with Deepstar
- ▼ Emulsions
 - Effect of flow field / oil properties on emulsion stability
 - NMR imaging of emulsions
- ▼ Brine Chemistry / Scale

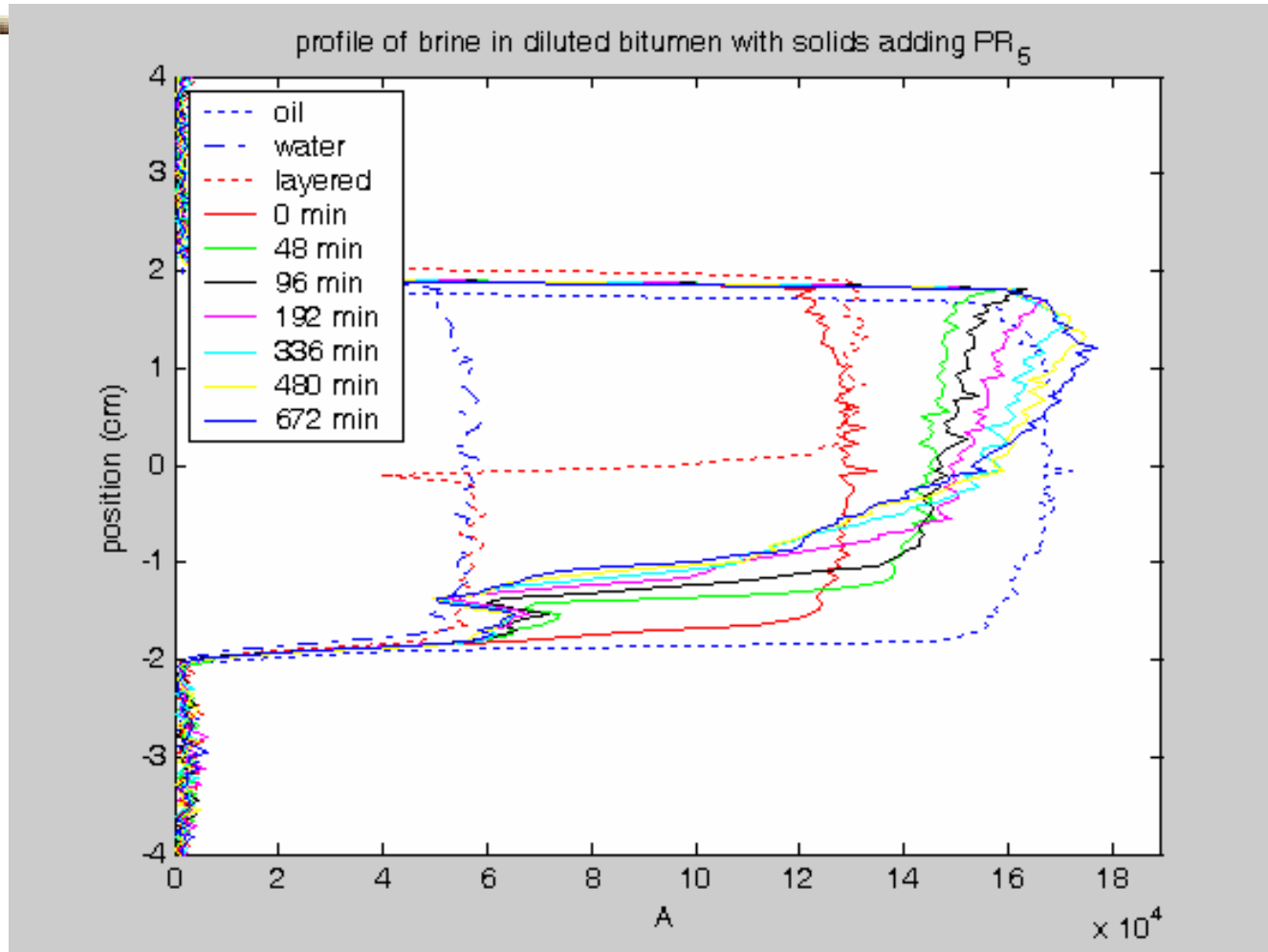


Hydrate Flow Assurance

- Objective
 - » Technology to predict nucleation and aggregation of hydrate particles in emulsified systems
 - » To quantify tendency to form hydrate plugs in production systems
- Issue
 - » Previous lack of direct methods to measure hydrate formation
- New Technology
 - » NMR spectroscopy is a direct method to measure formation and dissociation of hydrates in black oil (Gao et al., 2005)
 - » NMR combined PGSE-CPMG method to measure drop size distribution in water-in-oil emulsions (Peña et al., 2003)



Emulsions of brine in diluted bitumen with solids adding PR5



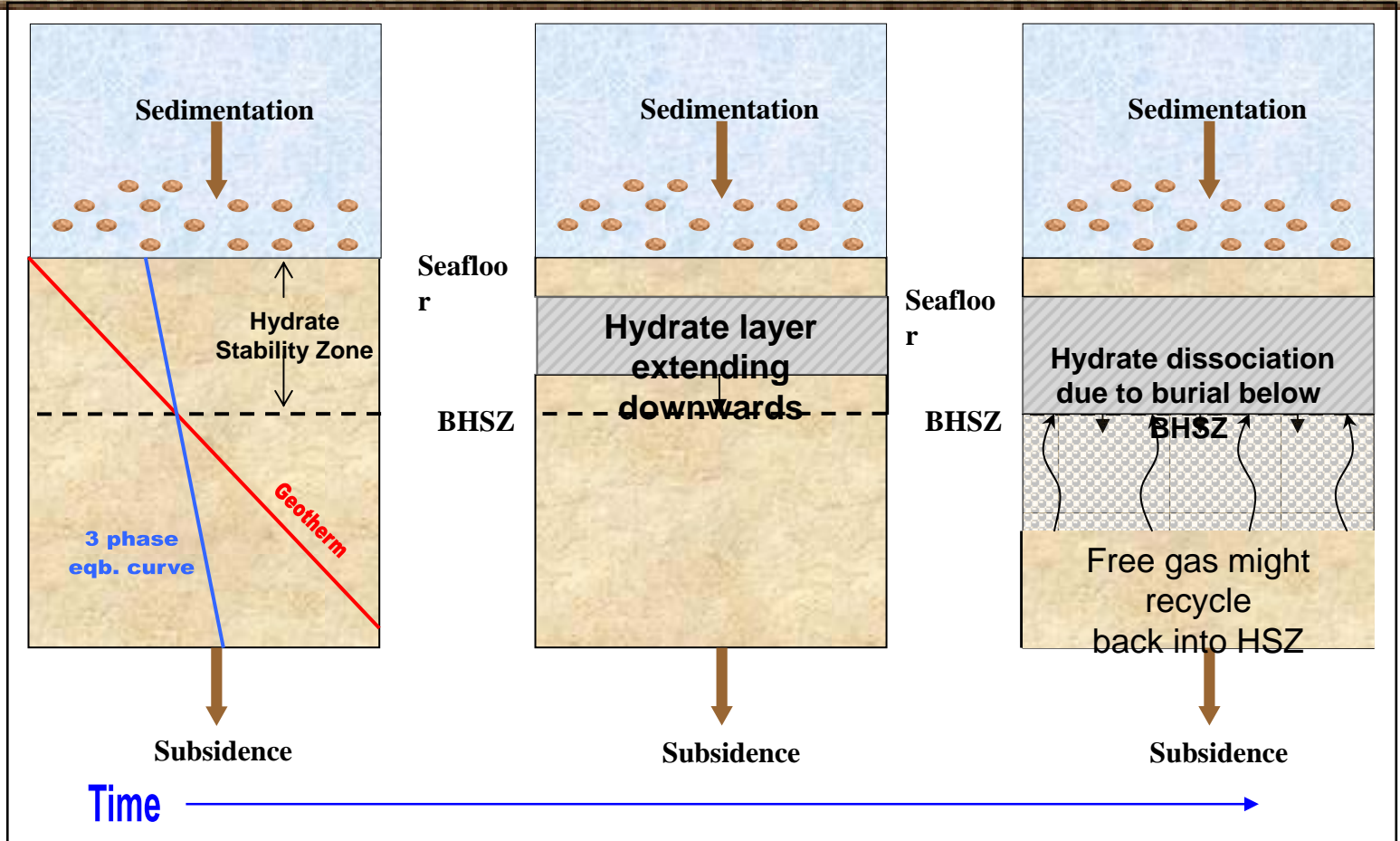
Profile results

Accomplishments

- The SAFT EOS model predicts the onset of asphaltene precipitation in live oils at in-situ conditions using SARA analysis, GOR, GC composition and experimental asphaltene characterization .
- This model predicts asphaltene phase behavior under different scenarios:
 - Pressure depletion
 - Gas injection
 - OBM contamination effect
 - Commingled Fluids
 - Temperature effect
- Model available in InfoChem Software
- Study different substrates adsorption tendency. Evaluation of coating material to mitigate asphaltene precipitation

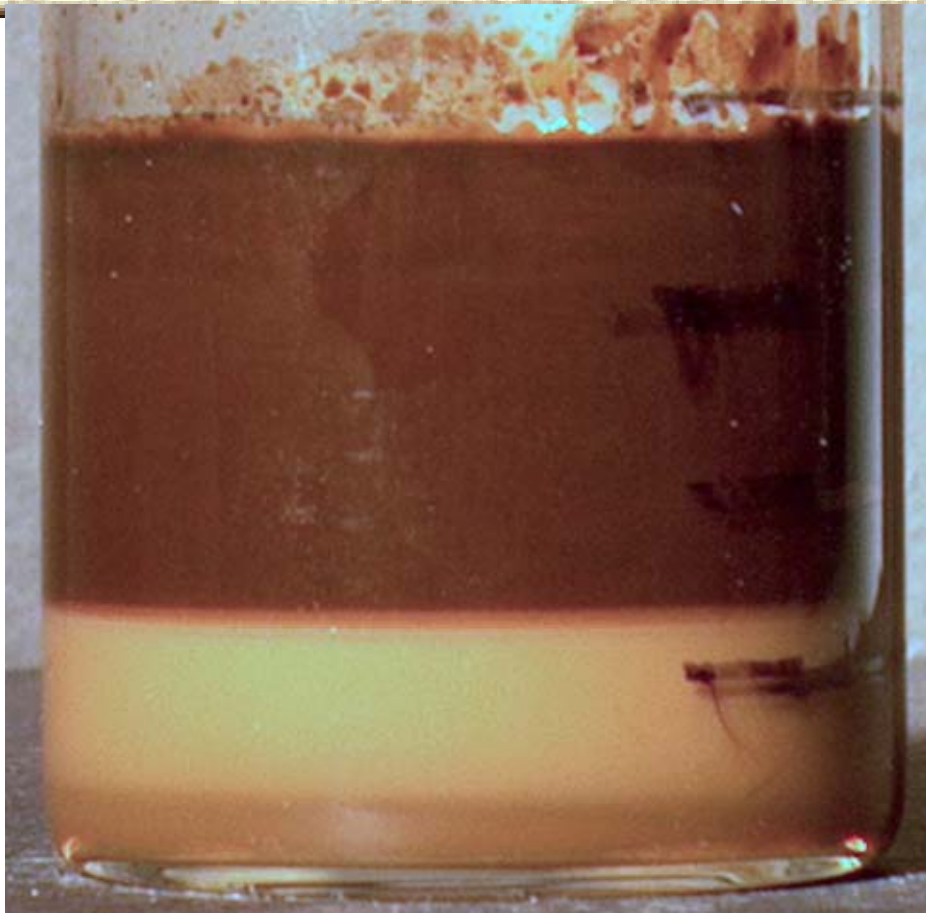


Hydrate Subsea Distribution

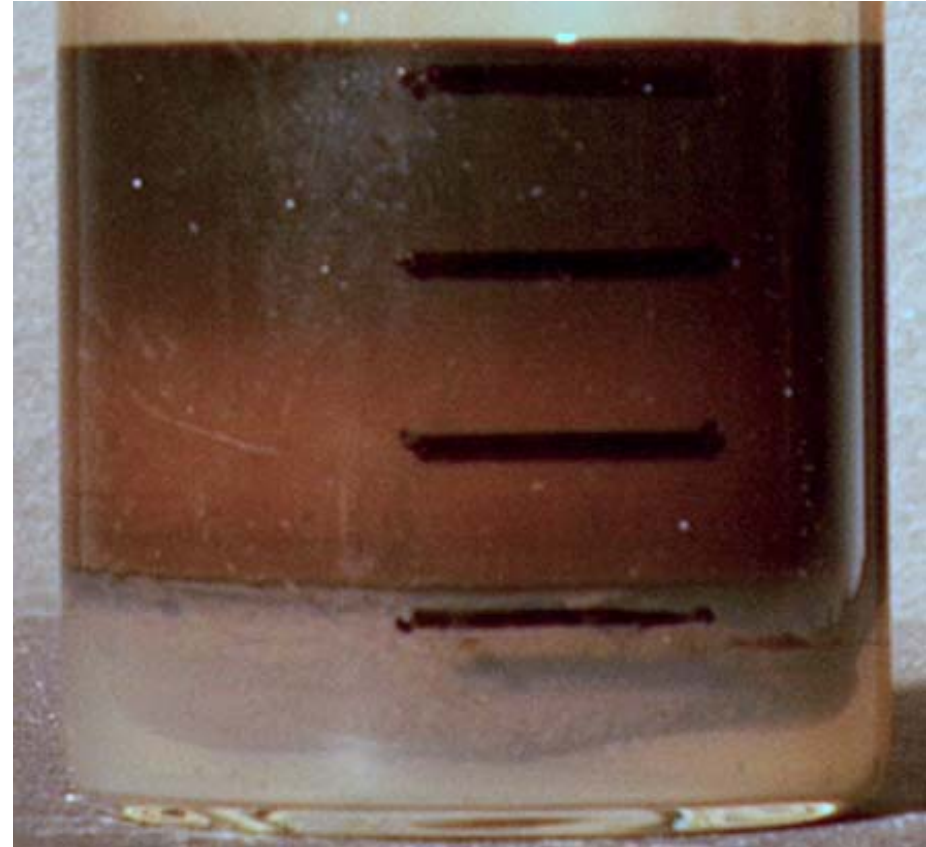




Emulsions of Brine in Diluted Bitumen with Solids 12 h after Preparation

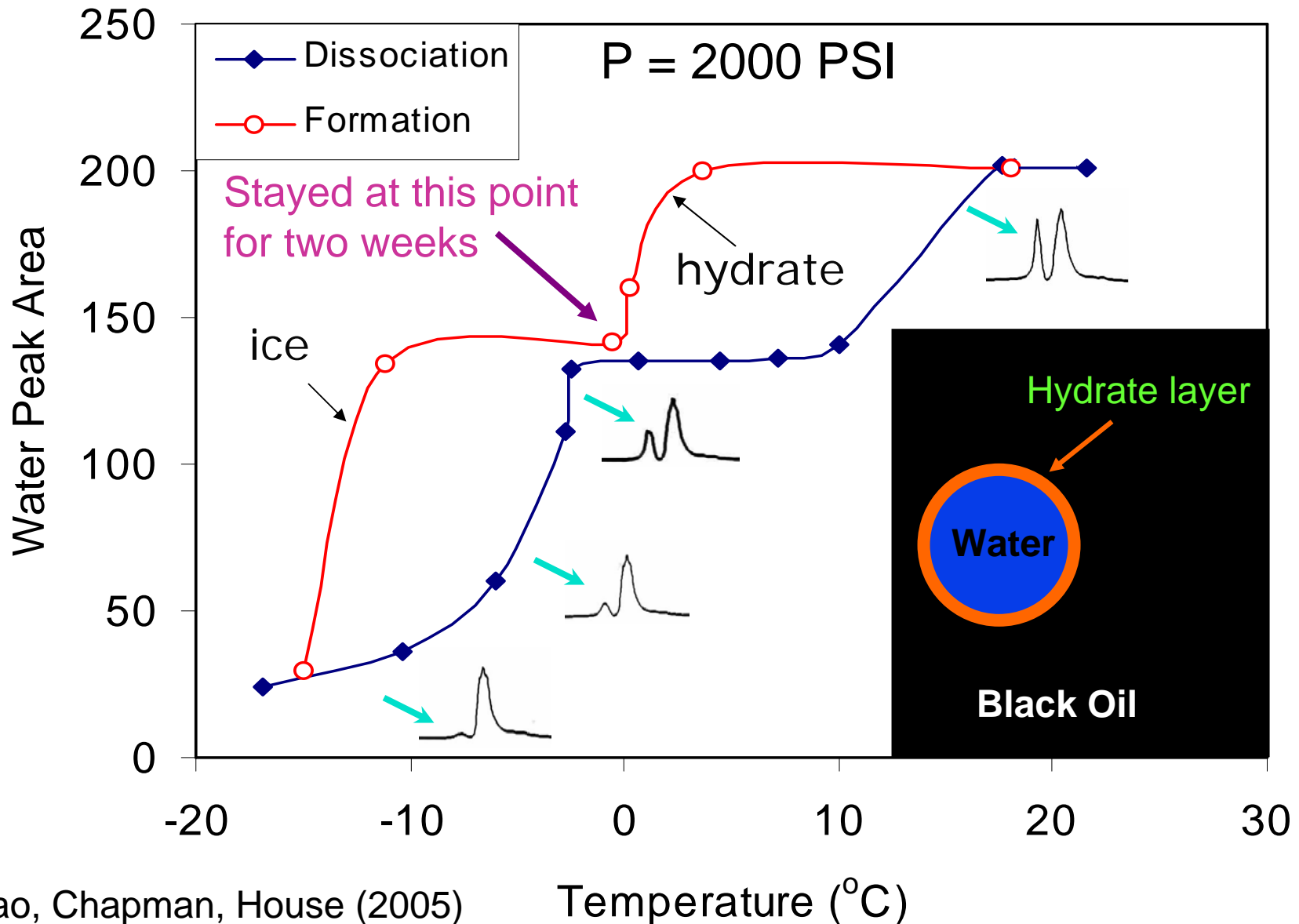


Without adding PR5



Adding PR5

Hydrate in Black Oil from NMR





Hydrate Research at Rice

Rice Team Members

Yildiz Bayazitoglu (Mech. Engr.)

Ed Billups (Chemistry)

Walter G. Chapman (Chem. & Biom. Engr.)

Jerry Dickens (Earth Science)

Brandon Dugan (Earth Science)

George Hirasaki (Chem. & Biom. Engr.)

Amy Jaffe (Baker Institute)

Paul Spanos (Mech. Engr.)

Colin Zelt (Earth Science)

Other Team Members

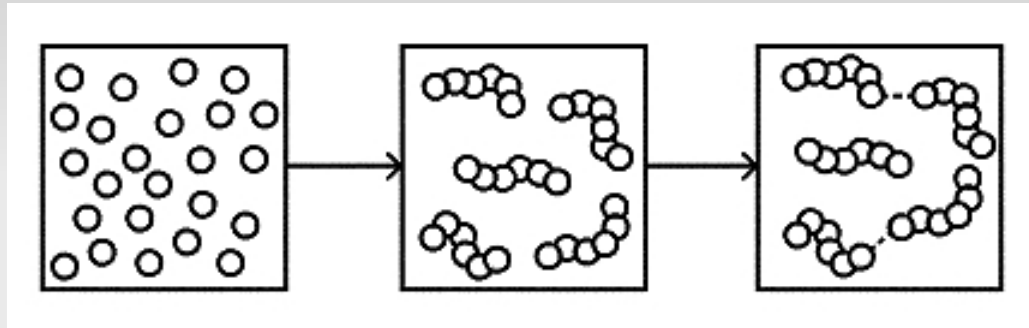
Raj Bishnoi (Univ. of Calgary)

Waylon House (Texas Tech)

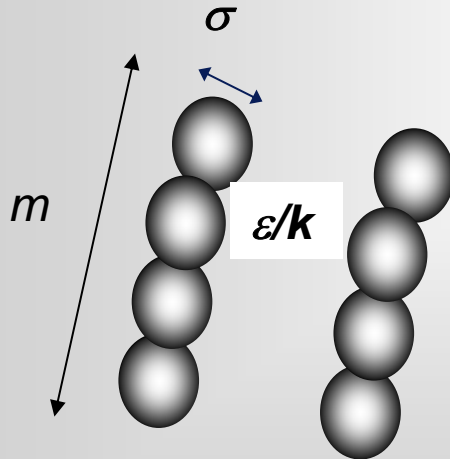
Kishore Mohanty (Univ. of Houston)

Kalachand Sain (Nat. Geophys. Res. Inst., India)

The PC-SAFT equation of state



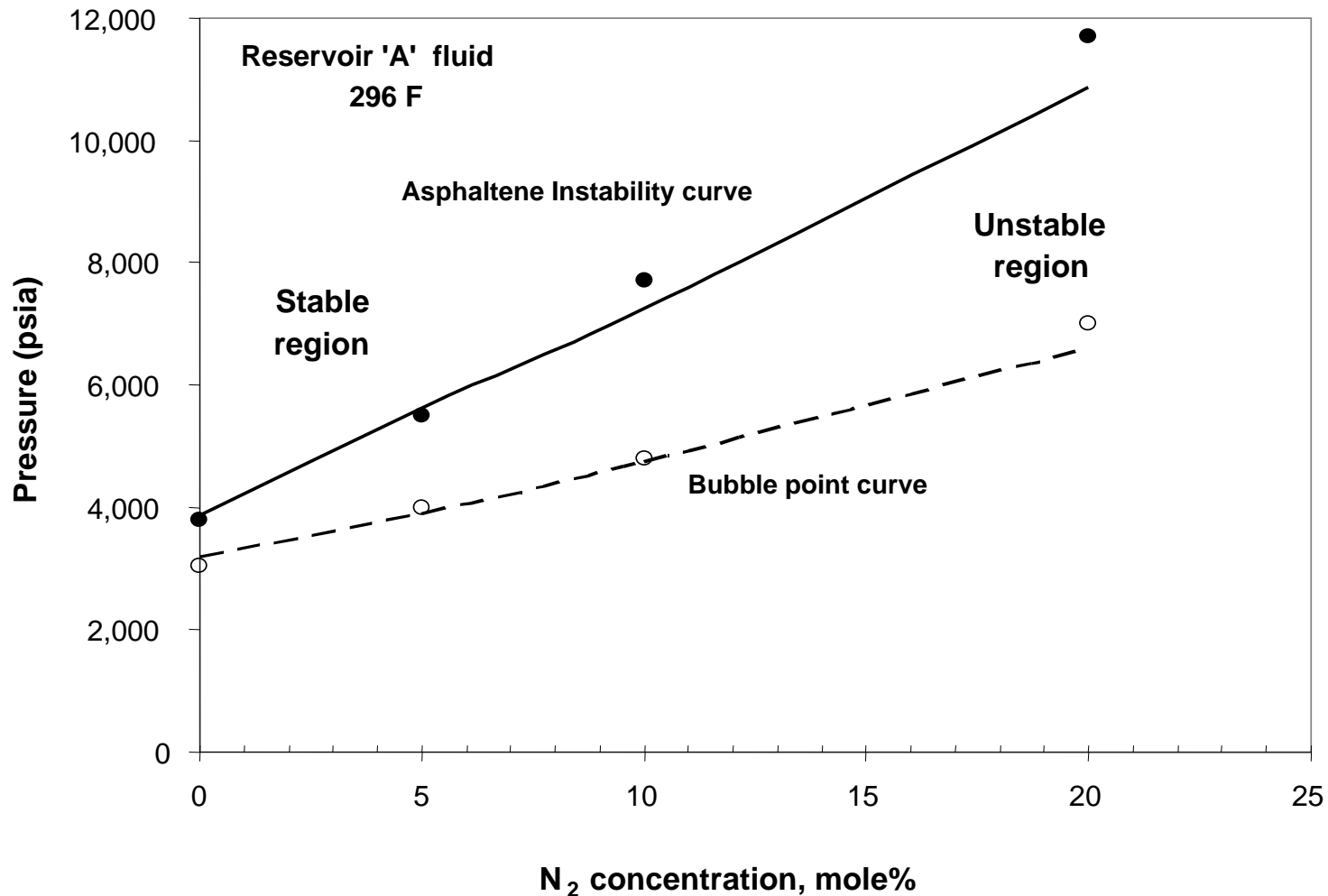
$$\frac{A^{res}}{RT} = \frac{A^{seg}}{RT} + \frac{\Delta A^{chain}}{RT} + \frac{\Delta A^{assoc}}{RT}$$



Physically based parameters:

- Segment size (σ)
- Number of segments in a molecule (m)
- Segment-segment interaction energy (ϵ/k)

Prediction of Asphaltene Precipitation



PC-SAFT - predicted and measured (Jamaluddin, et al., 2001) asphaltene instability onset and mixture bubble points as a function of nitrogen concentration in a recombined oil at 296°F.