Research Objectives
The following objectives have been set forth to address these significant tight gas production issues.
1. Existing and new geologic data will be used to create fracture network maps.
2. Propagation of hydraulic fractures given the natural fracture system and the existing stress condition in the system will be examined.
3. Gas production from these systems will be studied by combining the natural and hydraulic fractures into multiphase discrete fracture network reservoir models.

Approach
Outcrop, log and other data will be used to create static fracture models, which will be evolved into dynamic models by considering well tests. State of the art geomechanical tools will be used to obtain hydraulic fracture geometries, given the fracture/stress state of the reservoir. These geometries will be represented explicitly in The University of Utah discrete-fracture network reservoir simulators to obtain realistic assessments of gas production from tight gas reservoirs. The project team will develop a protocol for creating field-wide natural fracture networks, given static and dynamic reservoir information. Tools will be developed to determine more realistic hydraulic fracture geometries in vertical and horizontal wells. This will provide better understanding of designing hydraulic fractures to intersect existing natural fractures. Reservoir simulation of these realistic features will help optimize drainage and minimize costs.

Accomplishments
The gas-bearing Mesaverde formation was described using logs, cores and outcrops. The fracture system in Section 21 in the Natural Buttes natural gas field was characterized by using a variety of geologic data including FMI, logs and core supplemented with findings from the outcrop field studies. Validation of the fracture network was carried out by simulating microseismicity for a multistage hydrofrac conducted at nearby Chipeta wells. This validation produced reasonable correspondence between simulated and observed microseismic clouds. The geometry was also simulated in a geomechanical simulator capable of incorporating natural fractures. This geometry was transferred to an unstructured grid flow simulator. A new geomechanical tool was built into reactive transport flow simulator.

Significant Findings
Multiple pathways of incorporating geologic data to create natural fractures, embedding hydraulic fractures in this complex geometry and performing multiphase flow simulations were demonstrated. It was shown that microseismic information can be used to validate a hydraulic fracture created in a natural fracture environment. Flow simulations were used to show that partial closing of some of the fractures will significantly affect gas flow rates. Multiphase phenomena, such as water-gas relative permeabilities and water blocks, also are critical in determining gas deliverability.