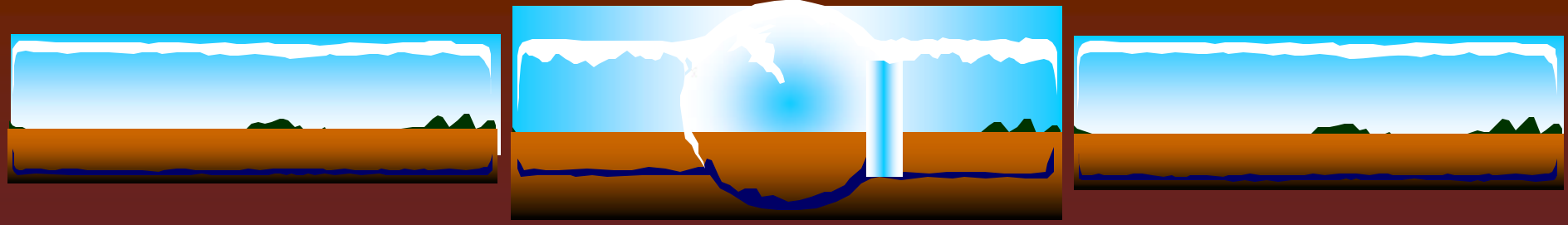

DOE's EGS Program Review

Fracture Propagation and Permeability Change under Poro-thermoelastic Loads & Silica Reactivity in Enhanced Geothermal Systems

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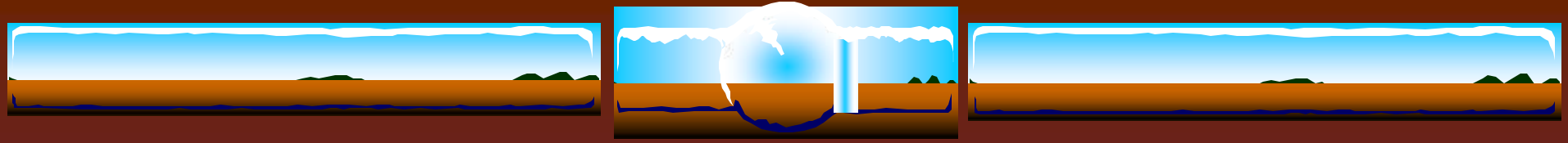
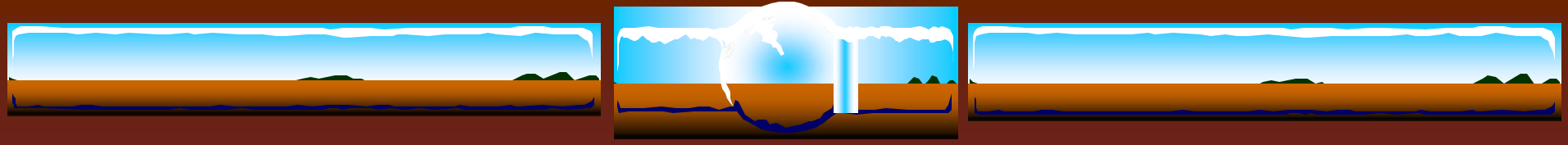
Golden, CO



Project Objective

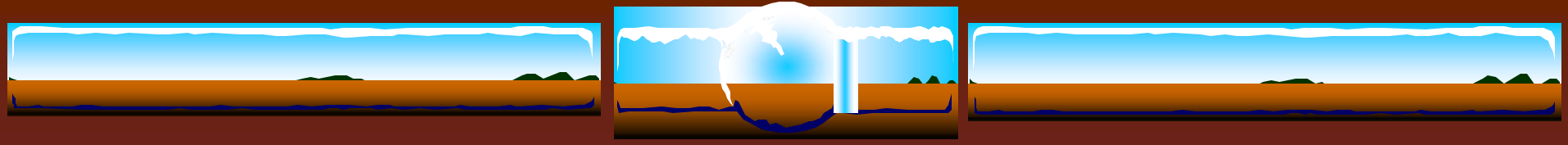
- Develop two- and three-dimensional poro-thermo-mechanical models to study fracture response to water injection, including mode I and II fracture propagation

- Investigate the variation of fracture permeability and fluid pressure near injection/extraction regions of EGS while considering coupled poro-thermoelastic effects and mineral precipitation/dissolution processes



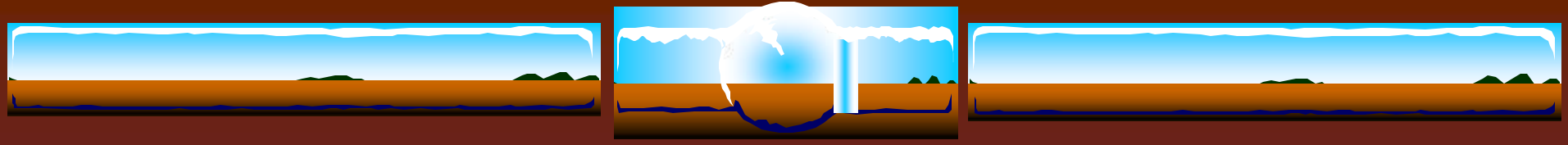
EGS Problem

- Why is project important to EGS program?
  - Major technical obstacles to attaining near-term EGS program goals and objectives include reservoir design and development in deep, low permeability rocks
  - Numerical models that accurately predict fracture growth and permeability development as a function of stimulation options and reservoir properties are needed
- What technical issue does the project address?
  - Influence of rock type and loading on fracture formation and growth
  - Fracture stimulation and fundamental studies of processes and procedures designed to enhance fracture permeability
  - Fracture stimulation-fundamental studies of processes to enhance fracture permeability considering stress, and chemistry
  - Fracture permeability and increasing flow capacity near injection and production wells
- How will project help to achieve overall program goals?
  - This research will facilitate technology development for decreasing the cost of electricity from EGS to less than 5 cents per kWh; and increase the economically viable geothermal resource to 40,000 megawatts



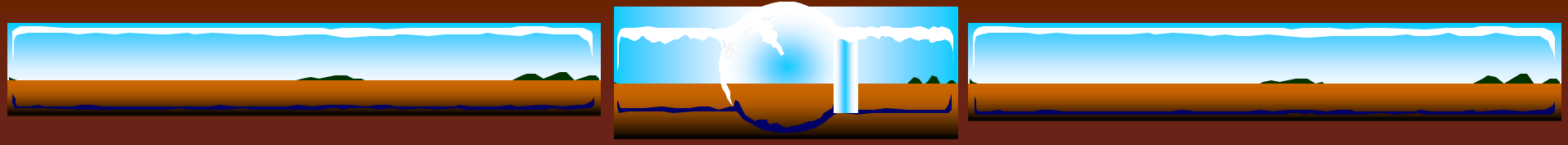
Background/Approach

- Fully-coupled poro-thermoelastic DD model with fracture propagation
  - investigate transient fracture behavior under coupled loading
- Partially-coupled three-dimensional poro-thermoelastic DD model
  - study fracture slip & permeability variation in 3D
- Coupled chemo-poro-thermoelastic model
  - study impact of combined mechanisms on fracture permeability



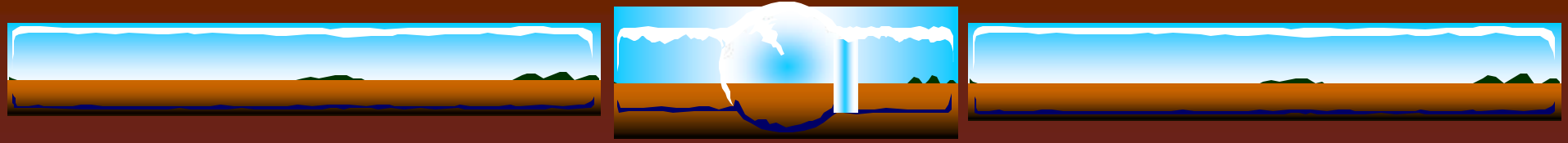
Results/Accomplishments

- Expected accomplishments (I)
  - develop a 2D coupled model to study/explain the role of coupled thermal and poroelastic processes on fracture propagation (length, aperture, direction); investigating the response of the reservoir to injection with regard to induced seismicity
  - develop a 3D partially-coupled fracture model consistent with the conceptual model of stimulation in EGS namely, fracture slip
  - apply the models to simulate injection experiments in Coso
  - studying fracture permeability change with injection (3D)
  - assess the role of injection/extraction on induced seismicity (3D)



Results/Accomplishments

- Expected accomplishments (II)
  - use analytical/numerical models to infer the individual & combined influences of thermal, poroelastic, and silica dissolution/precipitation processes on fracture permeability and pressure change in the near field regions
  - consider the effects of temperature, pore pressure, and silica precipitation/dissolution by development of a poro-thermo-chemical hybrid finite difference-boundary element model (FD-BEM)
  - apply the model to study fracture permeability and pressure evolution in injection experiments in Desert Peak injection



Conclusion

- It is expected that project objective will be achieved by the project completion date
  - the project will improve understanding of
    - fracture initiation/propagation
    - dynamics of fracture permeability
    - stimulation outcome
  - provide industry with the state-of-the-art knowledge system/technology essential for effective reservoir development, resource enhancement, and cost reduction