Death Valley Regional Groundwater Flow System

Presented to:
U.S. Nuclear Waste Technical Review Board Panel on the Natural System

Presented by:
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Team Project

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• Joan Blainey (AZ)
• Claudia Faunt (CA)
• Mary Hill (NRP)
• Randy Laczniak (NV)
• Carma San Juan (YMP)
• Don Sweetkind (GD)
Topics of Discussion

- Overview and conceptual model
- Geologic emphasis
- Tasks
- Groundwater flow model description
- Fluxes to site-scale Yucca Mountain Project (YMP) model
- Report outline, knowledge exchange, and potential future work
- Questions and discussion
Death Valley Regional Flow Model Area

- Large area with complex geology
- Potential high-level nuclear waste repository, Yucca Mountain, Nevada
- Groundwater flow paths from Nevada Test Site
- Update of previous modeling efforts
- Constructed using MODFLOW-2000
- Time period 1913-1998
Conceptual Model(s) of Groundwater Flow System
Geology is Half the Equation

\[ KA = \frac{Q}{(dh/dl)} \]

### Framework
- Unit geometry/truncation
- Location of high K zones
- Groundwater barriers
- Heterogeneity/anisotropy
- Actually doesn’t provide K

### Hydrology
- Model observations (hydraulic heads and discharge rates)
- Weighting/error factors for calibration
- Constrains K

\[ \frac{Q}{(dh/dl)} = KA \]
Comprehensive Geologic Interpretation in Support of the Regional Flow Model

- Synthesis of geologic maps
- Interpretation of regional tectonics
- Regional geologic cross-sections
- Geophysical interpretations
- Stratigraphic analysis of tertiary basins
- Hydrologic significance of structural and stratigraphic elements
Does Complex Geology Demand a Complex Flow Model?

- Ultimately depends on flow model
  - Availability of hydrologic data
  - Justified level of geologic detail
- Need to understand regional framework
  - Cross-section interpretations
  - Representation of structural zones
- Complexity is required in Death Valley region
  - Scale of geologic features
  - Previous modeling experience
**Tasks**

1. **Complete transient model and report**
   - Status reports (various dates)
   - Report to review (September 30, 2003)
   - Report completed (September 30, 2004)

2. **Model enhancements (various deliverables)**
   - Additions to MODFLOW (HUF, depth decay)
   - Model consistency
   - Predictive capability
   - Decision analysis
Report Outline

- Edited by Belcher
- Part A: Introduction (Belcher)
- Part B: Conceptual model of the regional geology and hydrogeology (by Sweetkind, Faunt, and Belcher)
- Part C: Conceptual model of the regional hydrology (by Faunt, D’Agnese, and O’Brien)
- Part D: Hydrogeologic evaluations (by San Juan)
- Part E: Hydrogeologic framework model (by Faunt, Sweetkind, and Belcher)
- Part F: Numerical model of groundwater flow (by Faunt, Hill, Blainey, O’Brien, and D’Agnese)
- Appendices: Databases and data sources (Bedinger and Harrill)
Model Discretization

- 1500 m grid cell spacing
  - 194 rows
  - 160 columns
- 16 layers (top layer > 50 m thick and is convertible), remaining layers follow water table at uniform thickness per layer and get thicker with depth
- Discharge represented by drains
- Recharge based on infiltration model
- Transient simulation (1913-1998)
- First stress period is steady state and replaces 2002 model
Recharge Based on Infiltration
Hydraulic Head Observations

EXPLANATION
HYDRAULIC-HEAD OBSERVATION
- Steady state (prepumped)
- Transient (pumped)
- Transient and steady state
Transient Simulation: Pumping

- Distribution of simulated wells
  - One well combined pumpage per cell

![Graph showing pumping rates over time](image)

![Map showing distribution of simulated wells](image)
Residuals and Simulated Potentiometric Surface

- **Validation**
  - Match discharge (ET and spring flow) rates and heads
  - Qualitative look at hydrochemistry
  - Calibrated using parameter estimation

- **Comparison to 2002**
  - Better match to flows
  - More head observations
  - Quantified boundary conditions
  - Transient with convertible upper layer
Comments

- **Regional model**
  - Good for answering regional questions
    - Examples:
      - Boundary conditions for site-scale models
      - Decrease in spring discharge based on pumping in region
      - Change in water levels based on pumping over time
  - Need more site-specific scale model to address more detailed concerns
# Fluxes to Site-Scale Yucca Mountain Project Model

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Knowledge Exchange
(Promised more than a model)

- **Deliverable 2003**: Model input and output (ASCII files, MODFLOW 2000 format)
- **Proposed deliverable 2004**: Integrated Knowledge System
- **Transform model input and output**: world coordinates, Geographic Information Systems (GIS) format
- **Databases**: (GIS, Hydrogeologic Framework Model Model (HFM), Access)
- **Basic analysis and visualization tools**
- **Proposed tasks 2004**:
  - Transfer and integrate supporting databases
  - GIS - hydrology (recharge, discharge - ET, springs, wells), HFM, well, topography, imagery, geology, geophysics, base maps
  - HFM - hydrogeologic data (2-D and 3-D)
  - Access - “model-ready” head and flow data
  - Transfer and integrate analysis and visualization tools
  - Custom tools developed by U.S. Geological Survey (USGS) (ArcGIS-based)
  - 3-D model
  - Data loaded in commercial software
The Future – FY05 and On

- Use local grid refinement to facilitate coordination between regional, Yucca Mountain site, and CAU models
- Use new methods to rank the importance of potential new observations, including long-term monitoring
- Use new methods to rank the importance of new HFM data
- Evaluate the effect of HFM uncertainty on predictions