

Development of the SPE & DAG Geologic Framework Models

Project Number (NST17-V-SPE Phase II-PD2Pa)

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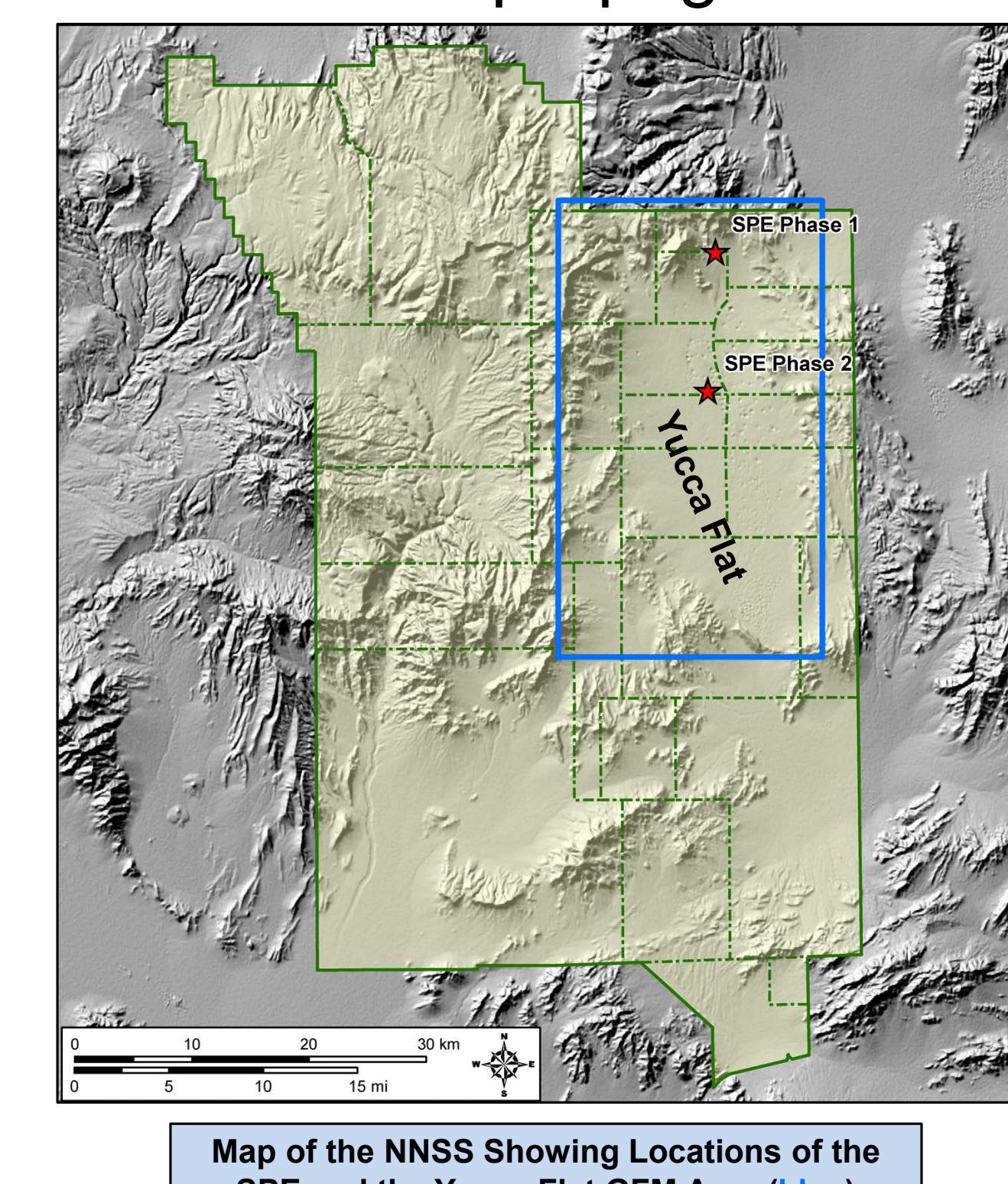


Goals and Objectives

- ▶ Provide geology-based 3-D framework for modeling seismic wave propagation from SPE explosions.
- ▶ Model the 3-D distribution of seismically relevant geologic features and physical properties.

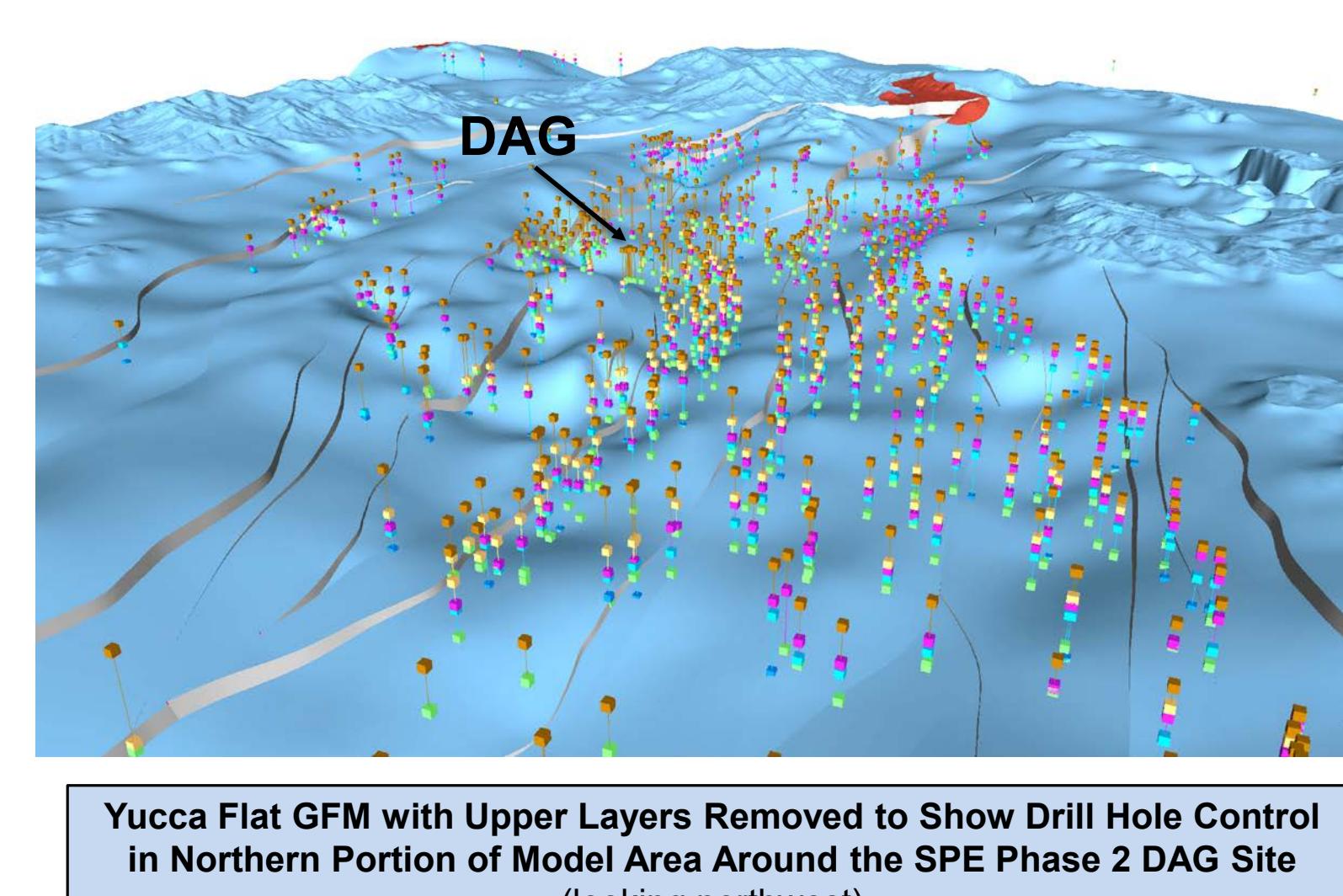
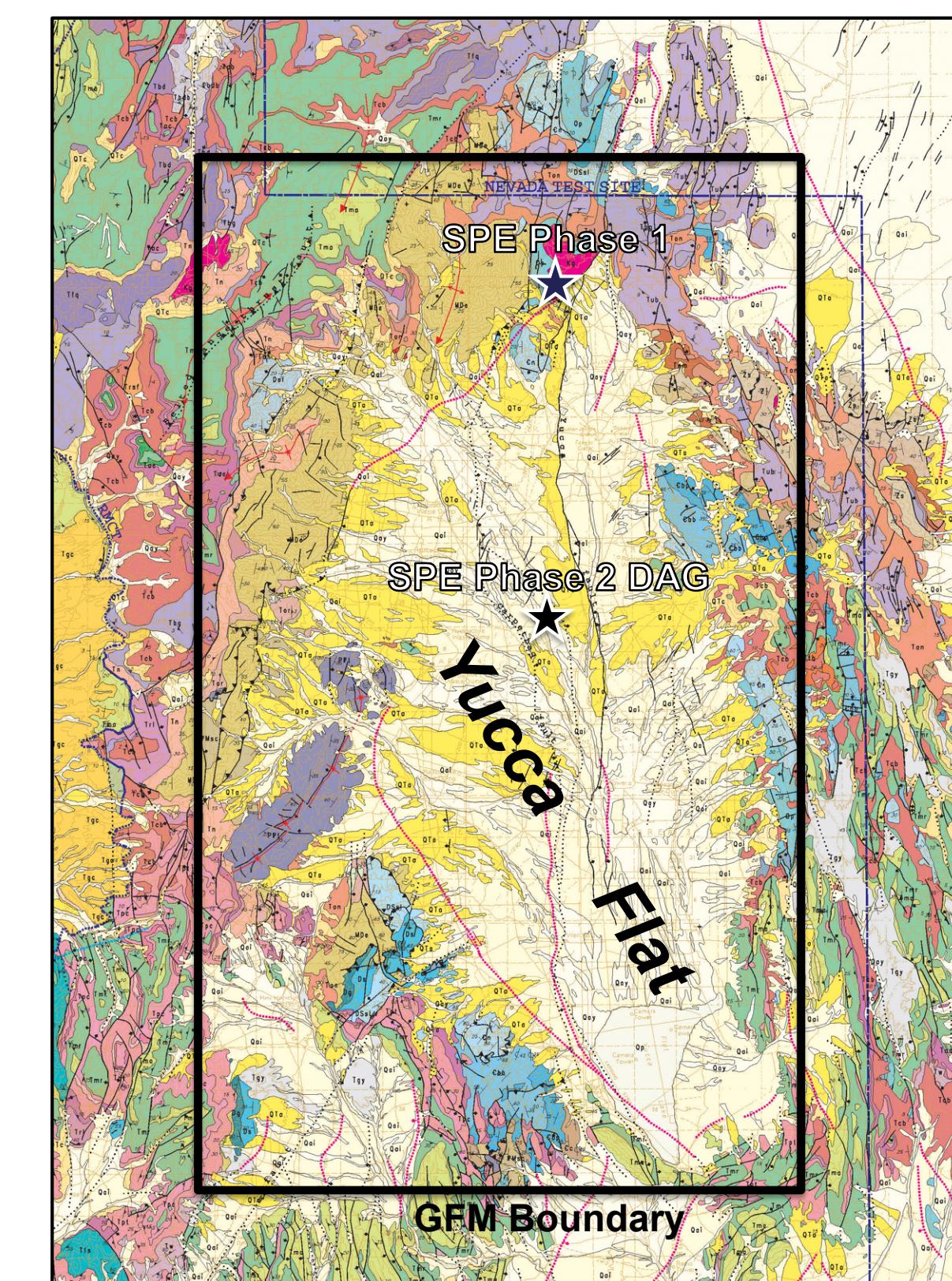
Introduction

The SPE is being conducted in and around Yucca Flat, an alluvium-filled basin located at the Nevada National Security Site (NNSS). The geology in the region is complex and diverse, which creates a challenge to modeling seismic wave propagation from SPE tests. We are addressing this challenge by building 3-D geologic framework models (GFM) that provide the distribution of relevant geologic features and physical properties necessary to effectively model seismic wave propagation.



Methods

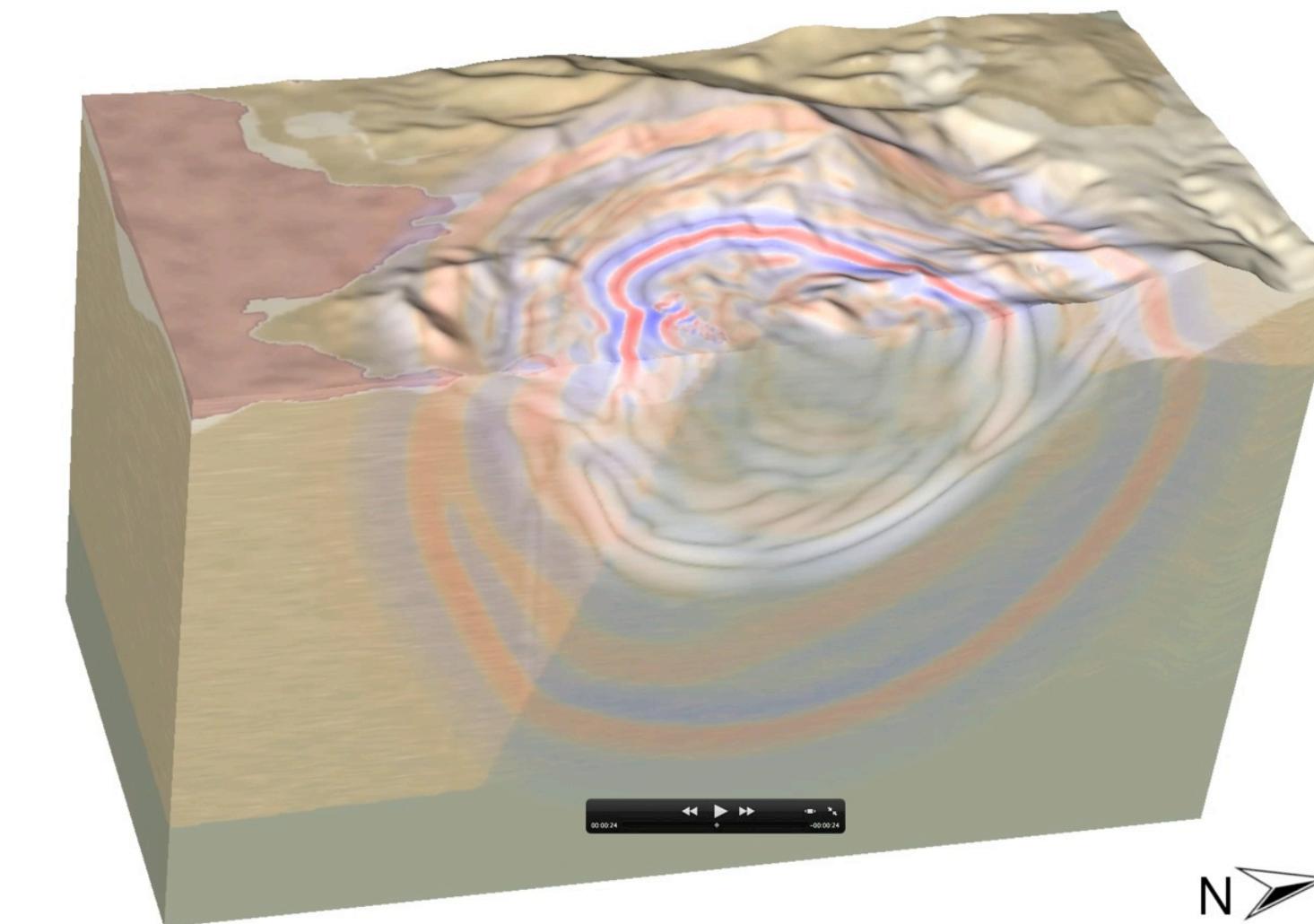
We are using the sophisticated 2-D and 3-D minimum tension gridding algorithms in EarthVision® and the large historical data sets available from more than 50 years of geological and geophysical studies at the NNSS to build the GFMs. Data from surface geologic maps, 659 drill holes, 2-D seismic reflection surveys, 5,400 downhole velocity measurements, and 10,000 gravity stations are used for GFM construction.



Results

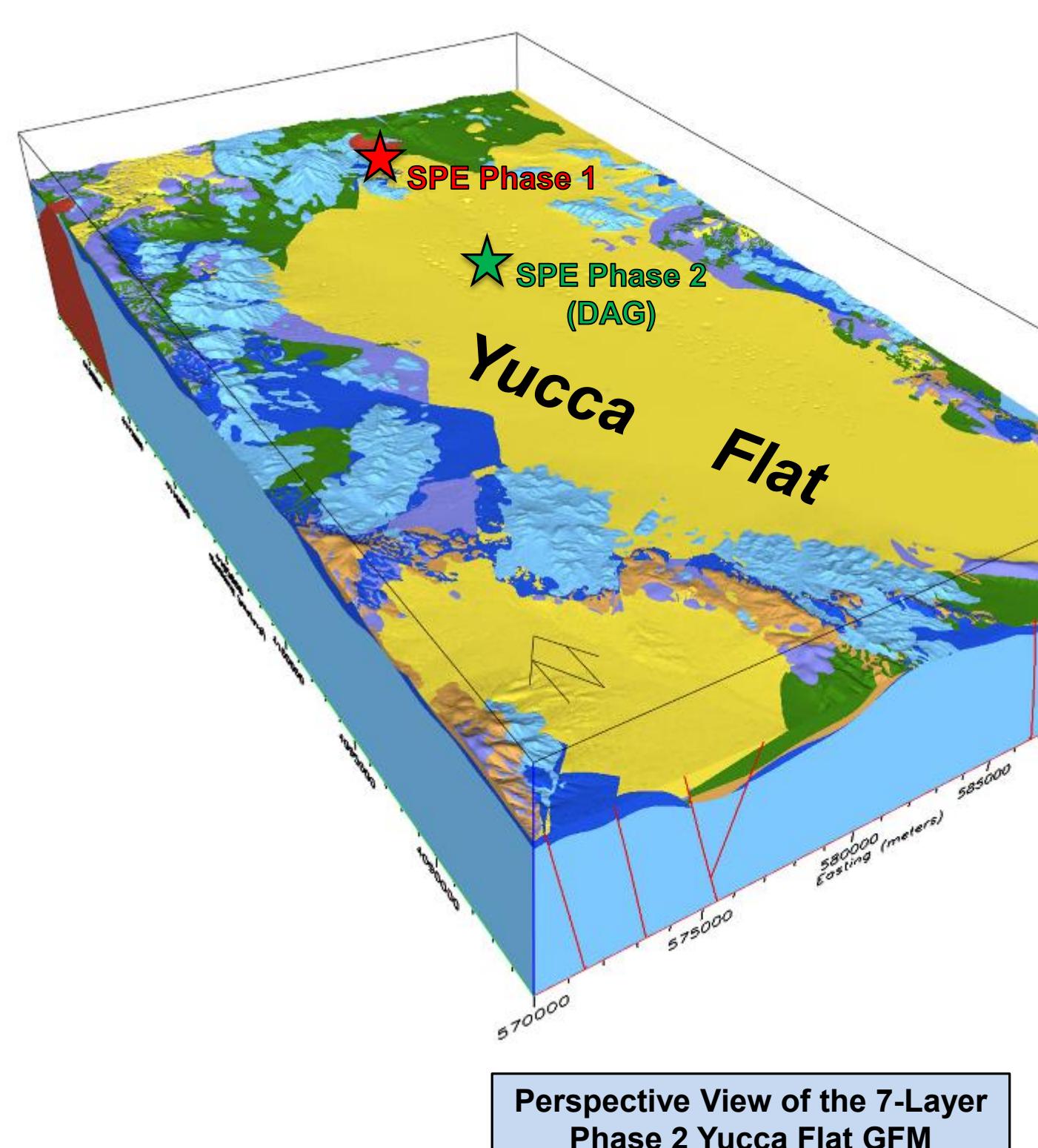
SPE Phase I GFM

A 4-layer GFM was successfully constructed and used for modeling seismic wave propagation from the SPE Phase 1 granite site at the north end of Yucca Flat.



Yucca Flat GFM

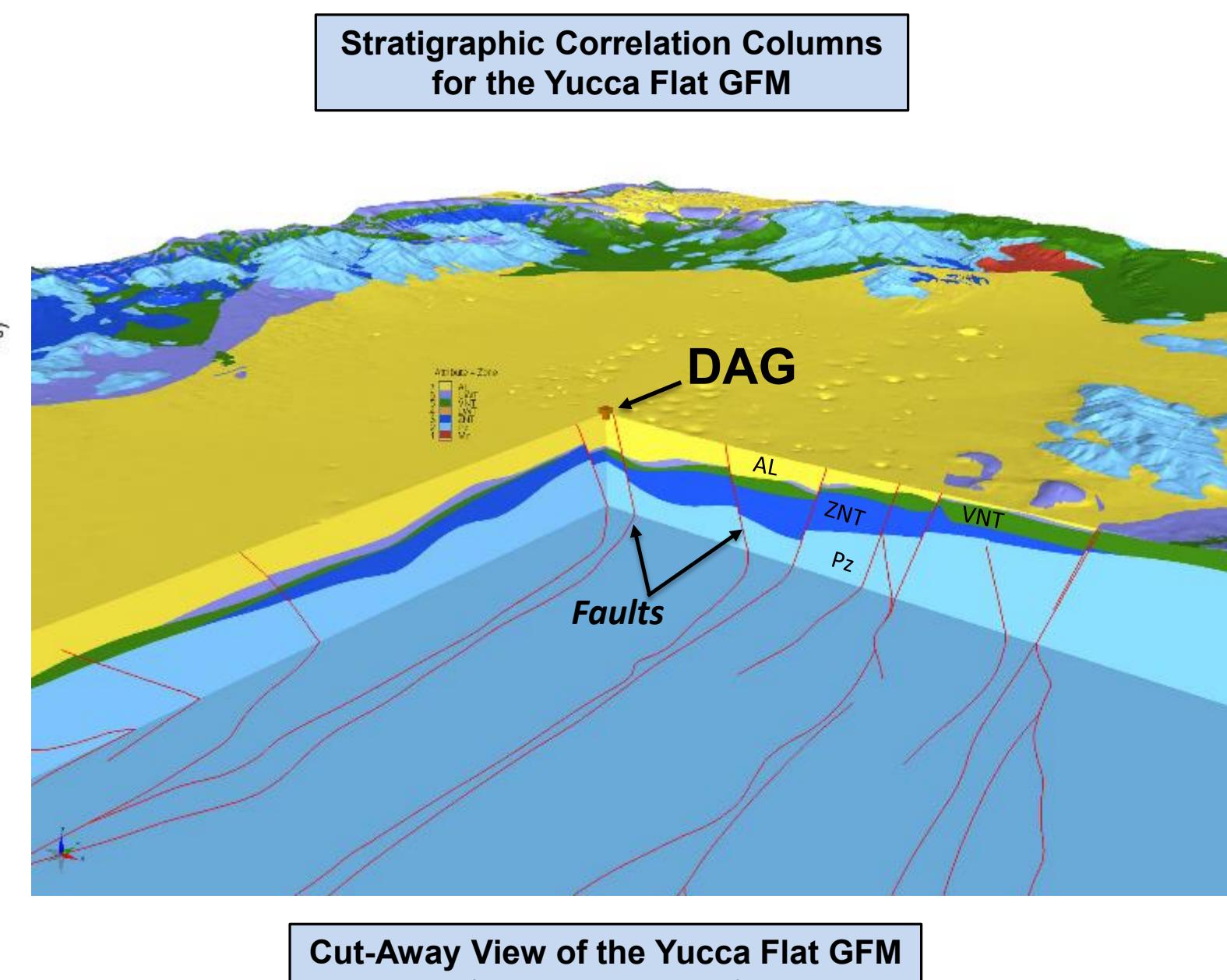
For the SPE Phase 2 Dry Alluvium Geology (DAG) series we merged the Phase I GFM with an existing, more detailed GFM developed for groundwater flow and contaminant transport modeling to increase model resolution within the Yucca Flat basin where DAG is located. This merged Yucca Flat GFM is currently being used for DAG pre-test simulations.



Discussion

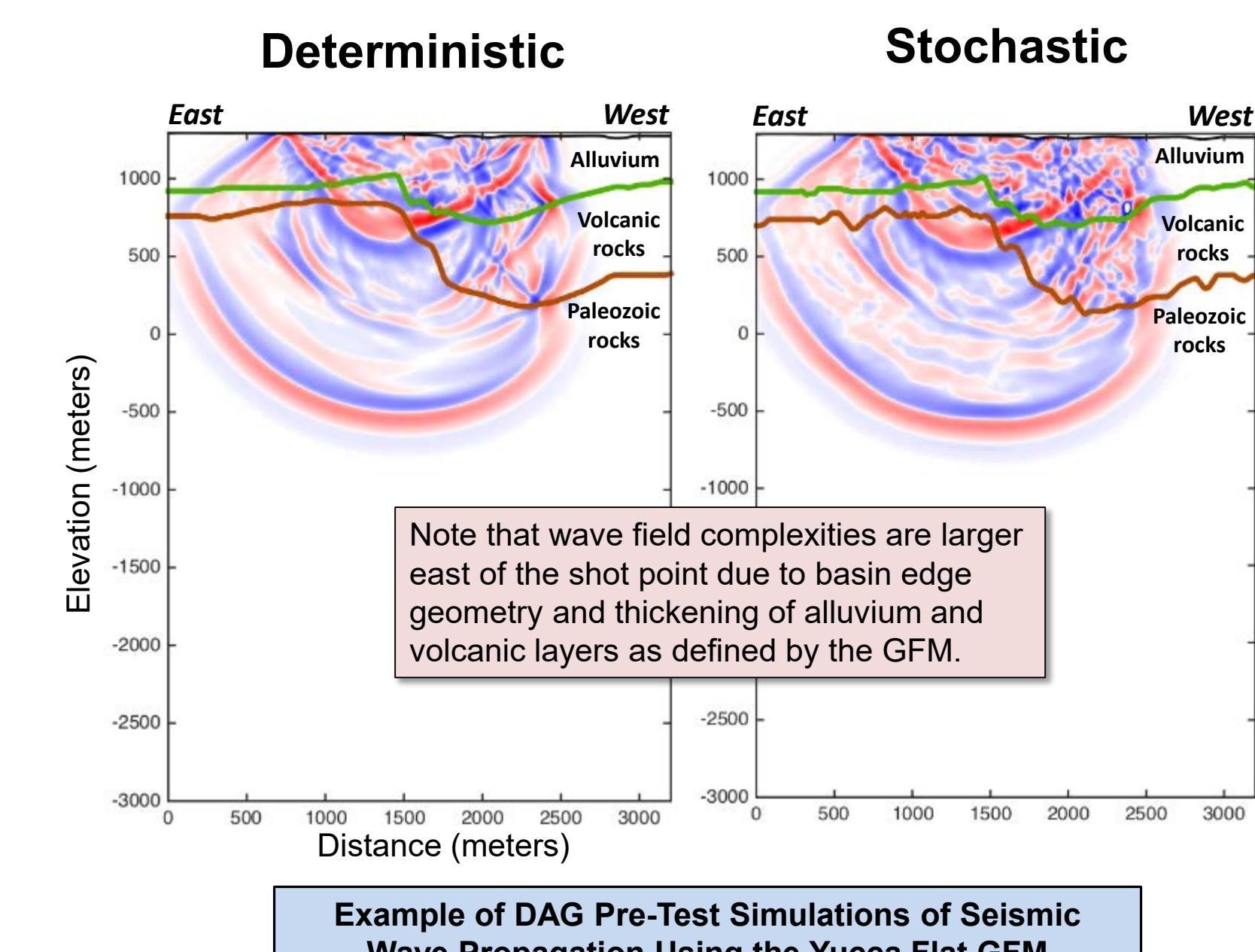
The current Yucca Flat GFM covers an area of 878 km² and includes all of Yucca Flat. The base of the model is at -4 km below sea level. The GFM includes 7 layers and 48 faults. Model layers are defined by their seismic properties, which are mainly determined by lithology and post-depositional alteration. Stratigraphic information is used to assure proper correlation of the layers throughout the model.

Stratigraphic Column	Stratigraphic Unit	GFM Layer
Q ₁	Playa deposits	Alluvium (AL)
Q _{2a}	Alluvium Eolian sand lenses	
Q _{2b}	Basalt of Yucca Flat	
Q ₃	Older Alluvium	
T _{1a}	Ammonia Tanks Tuff	Upper Welded Tuff (UWT)
T _{1b}	Bedded Ammonia Tanks Tuff	
T ₂	Rainer Mesa Tuff	
T _{3a}	Tuff of Tintic Road	Vitric Nonwelded Tuff (VNT)
T _{3b}	Tiva Canyon Tuff	
T ₄	Pantograph Group, undifferentiated	Lower Welded Tuff (LWT)
T ₅	Topopah Spring Tuff	
T ₆	Calico Hills Formation	
T ₇	Tuff of Wahmoose Flat	Zeolitic Nonwelded Tuff (ZNT)
T ₈	Crater Flat Group, undifferentiated	
T ₉	Bullfrog Tuff	
T ₁₀	Grouse Canyon Tuff	
T ₁₁	Tunnel Member beds 4E	
T ₁₂	Tunnel 3 Member beds 3BC (equivalent)	
T ₁₃	Tub Spring Tuff	
T ₁₄	Tunnel bed 2	
T ₁₅	Yucca Flat Tuff	
T ₁₆	Tunnel bed 1	
T ₁₇	Redrock Tuff	
T ₁₈	Redrock Tuff undifferentiated	
T ₁₉	Tuff of Twin Peaks	
T ₂₀	Postcalcareous Campanian-Miocene (Tintic)	
T ₂₁	Chambers-Shoshone (Elaine)	
T ₂₂	Elaine Formation	
T ₂₃	Cambrian-Devonian carbonate rocks	
T ₂₄	Pre-Cambrian segments	
M ₁	Paleozoic Rocks (PZ)	Paleozoic Rocks (PZ)
M ₂	Mesozoic Rocks (M2)	Mesozoic Rocks (M2)



Impact

GFM will continue to form the foundational frameworks for modeling seismic wave propagation from SPE detonations.



Future Work

- ▶ We will continue to refine the Yucca Flat GFM based on SPE-DAG results and to address specific needs and requests from modelers.
- ▶ We will continue to explore methods to enhance the GFM in the DAG near-field by adding detail in the alluvium and testing different fault offset configurations.

Publications/Deliverables:

Exports of the GFM are provided as requested from modelers. These include 2-D gridded surfaces of the top of each layer, or as 3-D gridded volumes. All exports are simple ascii text files.

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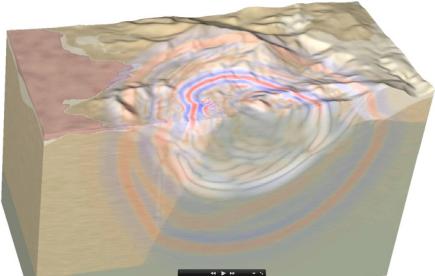
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Development of the SPE & DAG Geologic Framework Models

Geologic Framework Models (GFMs) – Providing 3-D frameworks for modeling seismic wave propagation

Background/State of the Art

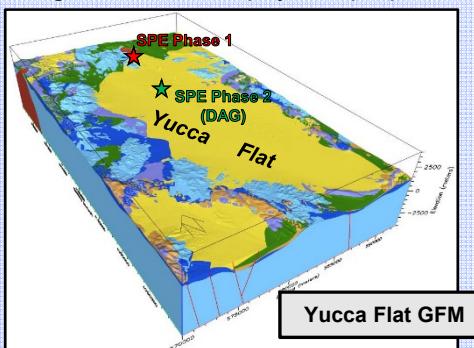
- The diverse and complex geology of the NNSA requires sophisticated 3-D geologic framework models (GFMs) to effectively model seismic wave propagation from SPE detonations.



Slice Through the 4-Layer Phase 1 GFM
Showing it Being Used for Seismic Wave
Propagation Modeling

Innovation

- We use minimum tension algorithms and large data sets from more than 50 years of scientific studies at the NNSA to model the 3-D distribution of seismically relevant geologic features and physical properties.

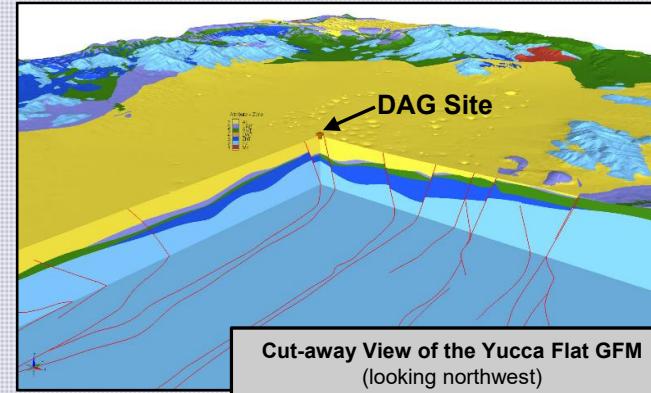


Defense Nuclear Nonproliferation R&D

Approach, Metrics and Outcomes

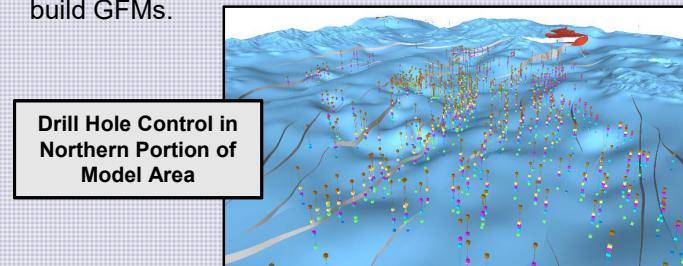
MAIN ACHIEVEMENT

- Our GFMs are being used by SPE scientists to model seismic wave propagation from SPE detonations.



HOW IT WORKS

- Data from surface geologic maps, 659 drill holes, 2-D seismic reflection surveys, 5400 downhole velocity measurements, and 10,000 gravity stations are imported into EarthVision® geologic model building application to build GFMs.

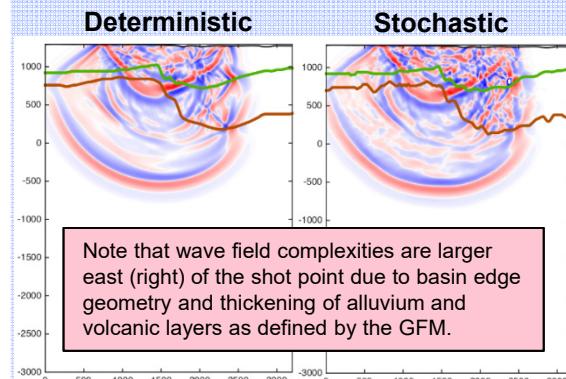


ASSUMPTIONS AND LIMITATIONS

- Uncertainty can increase rapidly away from data points due to the complex geological environment.

Impact

- GFMs will continue to form the foundational frameworks for modeling seismic wave propagation from SPE detonations.



Example of DAG Pre-Test Simulations of
Seismic Wave Propagation Using the
Yucca Flat GFM

Goals/Action Plan

- We will continue to refine the Yucca Flat GFM based on SPE-DAG results and to address specific needs and requests from modelers.

Team

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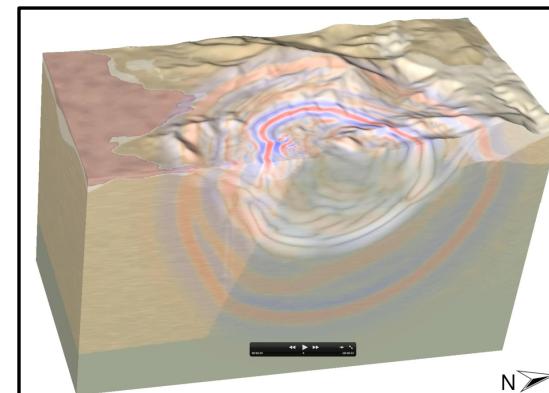
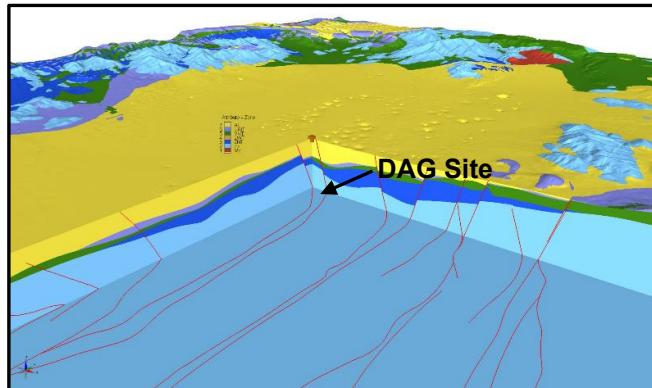
Margaret Townsend, MSTS, X124, 05/21/2018

Development of the SPE & DAG Geologic Framework Models

We are building complex 3-D geologic framework models designed to be used for modeling seismic wave propagation from SPE detonations in Yucca Flat.

We use sophisticated minimum tension algorithms and large data sets from more than 50 years of geologic and geophysical studies at the NNSS to model the complex 3-D distribution of seismically relevant geologic features and physical properties.

Our models are being used by SPE scientists to model seismic wave propagation from SPE tests in Yucca Flat.



Poster #45
Jeff Wagoner
LLNL

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