

## Death Valley, NV – Extensional Tectonics Workshop



<b>Type:</b>	Classroom and Field
<b>Instructors:</b>	James W. Granath
<b>Location:</b>	Las Vegas and Death Valley, CA
<b>Price:</b>	USD 4,600/person, all-inclusive (USD 4,200/person Double Occupancy if it can be accommodated)
<b>Length:</b>	5 days
<b>Time:</b>	October 8-12 <sup>th</sup> , 2018
<b>Registration:</b>	September 11 <sup>th</sup> , 2018

### Course Summary

Extensional structures provide some of the world's largest known oil reservoirs and remain one of the major frontier plays of the immediate future, both onshore and, particularly, in deep water offshore. 3-D seismic has revolutionized structural mapping. However, making the most realistic geologic interpretation of these structures is only as good as our ability to recognize and exploit the fundamental characteristics of the forms that are possible. This course presents outcrop, subsurface, seismic sections, and model analogs that will provide the starting point for structural interpretation in a wide range of extensional environments. Interpretations are validated by restoration and comparison to balanced models. This course covers the latest restoration techniques and the use of predictive kinematic models appropriate for rifted and other extensional and transtensional areas.

This is a five-day workshop designed to treat exploration problems presented by oil and gas activities in extensional environments, dominantly those of rift basins. The format is a 3-day classroom session emphasizing extensional geometries and seismic expression of the same, followed by a two-day, overnight excursion to Death Valley. This field trip crosses what's called the Death Valley extensional field, and covers the procedures for elucidating the structural style from surface geology and minimal seismic coverage.

### Instructor



**Jim Granath** is a consulting structural geologist based in the Denver, Colorado, area. He holds his PhD from Monash University in Australia, and a BS and MS from the University of Illinois at Champaign-Urbana. He specializes in structural analysis at all scales, hard and soft rock: traditional techniques as well as modern cross section construction/restoration, seismic interpretation; tectonics, and regional geological synthesis. Current research interests include intraplate block faulted terrains, both extensional and compressional, regional tectonics of Africa, and the Kurdistan thrust belt. He had 18 years of industry experience in a major in research, exploration and new ventures roles. He opened his consulting practice in 1999, focusing it on structural geology and tectonics as applied to exploration problems. He is on the Graduate Faculty of the University of Alabama, Tuscaloosa. Over the years he has worked on projects in some 40 countries, and is the author of numerous research papers and co-edited several multi-author compendia.

**James W. Granath, PhD**

## Learning outcomes

- Distinguish the characteristics of extensional and trans-tensional deformation for predominantly basement-involved, but with application to thin-skinned styles
- Apply mechanical-stratigraphic principles governing the formation and evolution of extensional structures and apply restoration and balancing techniques
- Predict structural geometry from sparse or inconsistent data using kinematic models
- Recognize typical extensional and trans-tensional petroleum-trapping geometries in seismic data sets

## Workshop Topics

- Extensional structural styles and their plate–tectonic habitats
- Models for rifting and passive continental margin evolution
- Trans-tensive structures
- Detached and basement-involved styles
- Map patterns
- Half grabens and full grabens
- Footwall uplift
- Pre-inversion normal faults
- Ramp-flat and listric-fault related structures
- Rotated block with keystone graben style
- Structural validation criteria
- Selecting the best balancing and restoration technique
- The variety of restoration ‘algorithms’ : rigid-block, flexural-slip, simple shear, trishear models of drape folds
- Area-depth technique for section validation, depth to detachment, bed-length changes and fault prediction
- Sequential restoration of growth structures

## Field Trip topics

- Mesozoic Servier thrust belt as expressed in the Spring Mountains: the grist for the extensional field
- Stateline fault and breakaway for Death Valley extensional field
- Rotated blocks and their breakaways: rotated domino blocks east of Death Valley
- Valley fill
- Greenwater Range, Black Mountains
- Amargosa chaos and the problem of early extension
- Death Valley itself, valley-parallel strike slip, turtleback structures in rotated fault plane
- Badwater on hanging wall, and Dante’s Point overview from footwall
- Structures along the Furnace Creek transfer fault zone
- Las Vegas shear zone and volcanism

## Itinerary

### Day 1 - Day 3 Classroom Las Vegas

### Day 4 Field

- Depart Las Vegas via shuttle
- All day in the field: Basin and Range structure between Las Vegas and Death Valley; underlying thrust belt geometries and their effect on the Tertiary structure
- Overnight Death Valley TBD

### Day 5 Field

- All day in the field: Death Valley structure and relationship to current western plate margin.



## Geological Itinerary

The following is a list of geological locations we visit. As this region is prone to summer monsoon with road washouts that are not necessarily repaired by the time we visit, the exact itinerary is dependent on conditions.

- Spring Mountains: foundation for the extensional terrane is the Mesozoic Sevier/Central Nevada thrust system and its alternating Mesozoic thrust/normal faulting in Mesozoic time
- Pahrump Valley: megascale picture of the breakaway and its relationship to the thrust systems. View of Nopah and Resting Spring Ranges: eastward rotation of hanging wall thrust features
- Resting Spring Pass volcanics: roadcut thru acid volcanics-obsidian dike and tuffs
- Rhodes Hill: Amargosa chaos and regional relationships of Black Mtns-Greenwater Mtns
- Vista of southern Death Valley, Jubilee Pass: more chaos relationships, DV itself, and relationship to Panamint Range
- Black Mountain front fault system just north of cut cinder cone: late faulting and its geometry
- Mormon Point and Copper Canyon Turtlebacks: element of Black Mtns fault system
- Badwater, Devil's Golf Course, and Zabriskie Point: Death Valley sedimentary fill
- Dante's View overlook: Death Valley regional structural features
- Mosaic Canyon: ductile deformation along rotated normal fault system
- Basement outcrops with dipping fanglomerates into Emigrant Pass detachment: rotated fill into fault surface in crystalline basement
- Emigrant Pass detachment and panorama view of north Panamint Valley: Hunter Mtn, Cottonwood Mtn
- Deformed fans along Furnace Creek Fault Zone; Eagle Mountain view: rotated thrust fold, basement blocks, and volcanics
- Rhyolite view: superimposed faults in Yerington-Bullfrog Hills areas
- Amargosa Valley, nuclear test center, Las Vegas shear zone

Return late (approximately 6:00 p.m.) Friday evening to Las Vegas

## Workshop Information

**Logistics:** Overnights in hotels, class room training in hotel meeting room, field trip with van

**Physical demand:** low, mainly outcrops along the road

**Pricing:** Price for the workshop is per participant for the entire course

**Included:**

- Hotel for 3 nights with breakfast in Las Vegas, NV
- Hotel 1 night with breakfast in Death Valley TBD
- Last night dinner in Death Valley
- Lunches for five days
- Transportation Las Vegas - Death Valley - Las Vegas
- Manuals and maps

**Not included:**

- Transportation to and from Las Vegas, NV
- Hotel before and after workshop
- Dinners except last night dinner in Death Valley