

**Tentative Schedule**  
**Structural Geology for Exploration and Mine Geologists**  
**19-28 March 2023, based in Tucson, Arizona**

Jointly sponsored by the Lowell Program in Economic Geology and the Arizona Geological Survey, University of Arizona  
 Organized by Carson A. Richardson and Eric Seedorff  
 Assisted by Rocio Brambila and Maximilian Britt, with many co-organizers and contributors

<b>Day 0</b>	<b>18 March 2023, Saturday</b>	<b>Ice Breaker; Tucson Marriott University Park Hotel (Terrace)</b>	
	All day	Registrants check into Tucson University Park Hotel, 880 E. Second Street, Tucson, Arizona 85719, 1-520-792-4100	
	<b>7:00pm - 9:00pm</b>	<b>Cash Bar Ice breaker, Terrace, Tucson Marriott University Park Hotel</b>	
<b>Day 1</b>	<b>19 March 2023, Sunday</b>	<b>Introduction and Overview of Fundamentals I; Talks and exercises in Sabino Room, Marriott</b>	
1	8:00am - 8:45am	Welcome, safety introduction, and introduction to the Structure Short Course	Carson A. Richardson and Eric Seedorff, with brief welcoming from Mark D. Barton (GEOS/UA) and Philip A. Pearthree (AZGS/UA)
2	8:45am - 9:15am	The nature of structural geology	Robert W. Krantz
3	9:15am - 9:30am	The need for this course in the minerals industry	Marc Bardoux
4	9:30am - 10:00am	Clint Dahlstrom and the two restrictions of Dahlstrom (1969): The grounding of structural geologic interpretations	Eric Seedorff
	<b>10:00am - 10:30am</b>	<b>Coffee break</b>	
5	10:30am - 11:15am	Structural geology and 3D thinking	Robert W. Krantz
6	11:15am - 11:45am	Why 3D structural geology	Marc Bardoux
E1	11:45am - 12:15pm	Map exercise: First exercise on analysis of geologic maps	Carson A. Richardson
	<b>12:15pm - 1:30pm</b>	<b>Lunch break</b>	
7	1:30pm - 3:00pm	Structural analysis: Geometry, kinematics, dynamics, and geomechanics	Robert W. Krantz
	<b>3:00pm - 3:30pm</b>	<b>Coffee break</b>	
8	3:30pm - 4:00pm	Fundamental types of structures: Faults, folds, joints, shear zones	Robert W. Krantz
9	4:00pm - 6:00pm	Faults, fault systems, and fault zones	Robert W. Krantz
<b>Day 2</b>	<b>20 March 2023, Monday</b>	<b>Introduction and Overview of Fundamentals II; Talks and exercises in Sabino Room, Marriott</b>	
10	8:00am - 8:45am	Folds	Calvin A. Mako
11	8:45am - 9:30am	Foliations and lineations	Calvin A. Mako
	<b>9:30am - 10:00am</b>	<b>Coffee break and AGS book sales</b>	
12	10:00am - 11:00am	Shear zones and relations between deformation and metamorphism	Calvin A. Mako
E2	11:00am - 12:15pm	Desktop exercise on stereonet: Analyzing planar and linear measurements	Calvin A. Mako and Carson A. Richardson
	<b>12:15pm - 1:30pm</b>	<b>Lunch break</b>	
13	1:30pm - 2:15pm	Using (or avoiding) planar measurements in volcanic terrains for assessments of paleohorizontal: Evaluating igneous flow foliation in lavas, compaction foliation in welded ash-flow tuffs, and bedding in fall, surge, and volcanoclastic deposits	Eric Seedorff
E3	2:15pm - 2:30pm	Moments with maps and outcrops: Volcanic rocks, upright and tilted	Eric Seedorff
14	2:30pm - 3:45pm	Structures developed during pluton emplacement: Peraluminous plutons such as Birch Creek, California, and plutons of other compositions	Mark D. Barton
	<b>3:45pm - 4:15pm</b>	<b>Coffee break and AGS book sales</b>	
15	4:15pm - 5:00pm	Volcanologic structures: Calderas and craters; rifts in shield volcanoes; resurgent domes vs. lava domes; keystone grabens; maars and diatremes	Eric Seedorff
16	5:00pm - 5:45pm	Polyphase folding: Insights regarding complexly folded rocks from surface and mine exposures	Marc Bardoux
	<b>6:30pm - 7:00pm</b>	<b>Cash bar, Canyon Room, Marriott</b>	
17	<b>7:00pm - 9:00pm</b>	<b>Dinner followed by talk, "Geologic Evolution of Arizona"</b>	Jon E. Spencer
<b>Day 3</b>	<b>21 March 2023, Tuesday</b>	<b>Crustal Shortening / Contraction; Talks and exercises in Sabino Room, Marriott</b>	

18	8:00am - 8:45am	Tectonic settings of shortening: Overview of subduction zones, thrust belts, and arcs, across globe and important	Amanda N. Hughes
19	8:45am - 9:15am	Crustal shortening: Mechanics of fold and thrust belts	Amanda N. Hughes
20	9:15am - 10:00am	Crustal shortening: Structural styles	Amanda N. Hughes
	<b>10:00am - 10:30am</b>	<b>Coffee break and AGS book sales</b>	
21	10:30am - 11:30am	Structural characteristics of greenstone belts	Marc Bardoux
	11:30am - 12:30pm	Informal brainstorming over geological maps of greenstone belts	Marc Bardoux
E4-A	<b>12:30pm - 1:45pm</b>	<b>Lunch break</b>	
E4-B	1:45pm - 2:30pm	Exercise on greenstone belts	Marc Bardoux
	2:30pm - 4:00pm	Creation of permeability in porphyry, base metal lode, and high-sulfidation deposits	Richard M. Tosdal
22	<b>4:00pm - 4:30pm</b>	<b>Coffee break and AGS book sales</b>	
23	4:30pm - 5:15pm	Tectonics and post-mineral structural geology of the Timok province, Serbia	Richard M. Tosdal
24	5:15pm - 6:00pm	Basement-cored uplifts, fault-propagation folds, and trishear fold-fault models	Amanda N. Hughes
25	6:00pm - 6:15pm	Preparation for field trip on Sunday with a map preview	Carson A. Richardson
<b>Day 4</b>	<b>22 March 2023, Wednesday</b>	<b>One-Day Field Trip on Mapping Laramide Contractional Structures, Huachuca Mountains</b>	
	6:45am	Assemble at front entrance of Marriott Hotel for a one-day, out-and-back field trip; be ready to depart for field trip at 7:00am; drive southeast on I-10 towards Benson and El Paso, but turn south at Exit 302 onto Arizona Hwy 90 towards	Carson A. Richardson and others
	8:00am	Biologic break at gas stations near I-10 and Arizona Highway 90	
	9:30am	Field exercise on northwestern side of Huachuca Mountains	
	3:30pm	Return to Marriott Hotel in Tucson; expected arrival at	
<b>Day 5</b>	<b>23 March 2023, Thursday</b>	<b>Crustral Shortening / Contraction; Extensional Deformation; Talks and exercises in Sabino Room, Marriott</b>	
26	8:00am - 8:45am	Laramide reverse faults and porphyry systems: Overview and map examples from porphyry districts of Arizona	Eric Seedorff
27	8:45am - 9:30am	Tectonic settings of extension: Overview of rifted continental margins, continental rifting, and extensional provinces across the globe and important ancient ones (including Aegean and Himalayas)	Amanda N. Hughes
	<b>9:30am - 10:00am</b>	<b>Coffee break and AGS book sales</b>	
28	10:00am - 11:15am	Free surfaces: Landslides and mega-landslides versus continental extension, with implications for detachment faults	Eric Seedorff
29	11:15pm - 12:00pm	Normal faults and fault systems: Growth from precursory structures; propagation in 3D; segmentation; relay ramps; half-grabens and growth sequences; flexure and along-strike variations in displacement and amount of tilting; configurations between crosscutting generations; amount of extension versus amount of tilting	Carson A. Richardson
30	12:00pm - 12:45pm	Unfaulting and untilting sets of brittle normal faults: Stepwise cross-sectional reconstructions and fault surface maps	Eric Seedorff
	<b>12:45pm - 2:00pm</b>	<b>Lunch break</b>	
E5	2:00pm - 2:45pm	Exercise on maps and structural reconstructions	Eric Seedorff
31	2:45pm - 4:15pm	Iron oxide-copper-gold deposits, with an emphasis on structural settings	Mark D. Barton
	<b>4:15pm - 4:45pm</b>	<b>Coffee break and AGS book sales</b>	
32	4:45pm - 5:45pm	Reclining rooted normal fault model for crustal extension and Cordilleran metamorphic core complexes, with applications to mineral deposits	Eric Seedorff
33	5:45pm - 6:00pm	Preparation for field trip with a map preview	Carson A. Richardson
<b>Day 6</b>	<b>24 March 2023, Friday</b>	<b>One-Day Field Trip on Mapping Brittle Extension, San Manuel Area</b>	
	6:45am	Assemble at front entrance of Marriott Hotel; pick up box lunch that is provided; be ready to depart for field trip at 8:00 am; drive north to Cottonwood Wash, between towns of San Manuel and Mammoth.	Carson Richardson, Eric Seedorff, and Adam D. Gorecki
	7:30am	Biologic break at gas stations along Oracle Road / AZ-77	

9:15am Hike down wash to site as group for field exercise; eat lunch; hike back to vehicles at end of exercise.

2:30pm Drive to overlook of reclaimed San Manuel mine site; geology of San Manuel-Kalamazoo and Tiger; story of discovery of Kalamazoo by David Lowell

4:00pm Return to Marriott Hotel in Tucson; expected arrival at

<b>Day 7 25 March 2023, Saturday</b>		<b>Extensional deformation; Strike-slip deformation; Talks and exercises in Sabin Room, Marriott</b>	
34	8:00am - 9:30am	Structural controls on ore in low-sulfidation epithermal gold-silver deposits	David A. Rhys
	<b>9:30am - 10:00am</b>	<b>Coffee break and AGS book sales</b>	
35	10:00am - 11:30am	Structural geology of Carlin-type gold deposits	Gerry Griesel
36	11:30am - 12:15pm	Exploring beneath the Roberts Mountains thrust: An example from the northern Shoshone Range, Nevada	Carson A. Richardson
E6-A	12:15pm - 12:30pm	Introduction to exercise: Normal fault restoration and exploration targeting	Carson A. Richardson
	<b>12:30pm-1:45pm</b>	<b>Lunch break</b>	
E6-B	1:45pm - 2:15pm	Exercise: Normal fault restoration and exploration targeting	Carson A. Richardson
37	2:15pm - 2:45pm	Restoring the "I-80 cross section" across northern Nevada: Examining the late Eocene surface when Carlin-type gold deposits formed	Carson A. Richardson
38	2:45pm - 3:30pm	Levels of porphyry systems and their structural dismemberment and tilting by reverse, normal, and strike-slip	Eric Seedorff
	<b>3:30pm - 4:00pm</b>	<b>Coffee break and AGS book sales</b>	
39	4:00pm - 5:30pm	Structural geology of orogenic gold deposits across crustal levels and time	David A. Rhys
40	5:30pm - 5:45pm	Preparation for field trip on Thursday with a map preview	Carson A. Richardson
<b>Day 8 26 March 2023, Sunday</b>		<b>One-Day Field Trip on Brittle-Ductile Extension, Tanque Verde Falls, Rincon Mountains</b>	
	6:45am	Assemble at front entrance of Marriott Hotel; pick up box lunch that is provided; be ready to depart for field trip at 8:00 am; drive east to Catalina Highway	Carson A. Richardson
	8:00am	Arrive at Tanque Verde Falls parking lot, distribute lunches, and hike down into wash	
	9:00am	Exercise sketching and annotating subdetachment fault	
	9:30am	Examine pseudotachylite exposures	
	10:15am	Break into groups for outcrop exercises on mylonitic shear zones and brittle faults	
	12:00pm	Lunch, followed by wrapping up remaining exercises	
	1:30pm	Return to Marriot Hotel; expected arrival 2:30pm	
<b>Day 9 27 March 2023, Monday</b>		<b>Strike-slip deformation; Structural geologic tools, examples, and applications; Talks in Sabino Room, Tucson Marriot</b>	
41	8:00am - 8:45am	Tectonic settings of strike-slip faulting: Overview of active fault systems from across the globe and important ancient	Amanda N. Hughes
42	8:45am - 9:30am	Review of mechanics of strike-slip deformation; transform faults; Riedel shears; bends in systems and transtension and transpression; transfers in displacement at stepovers; strike-slip duplexes and flower structures	Amanda N. Hughes
	<b>9:30pm - 10:00am</b>	<b>Coffee break and AGS book sales</b>	
43	10:00am - 11:15am	Structure in drill core: The importance of field observations in constraining its collection and interpretation	David A. Rhys
44	11:15am - 12:00pm	Tectonic geomorphology: Field evidence for recent and modern faulting, tectonic geomorphologic features, and case	Philip A. Pearthree
	<b>12:00pm-1:15pm</b>	<b>Lunch break</b>	
45	1:15pm - 2:00pm	Historic earthquakes (normal, reverse, and strike-slip) and what paleoseismology can tell us about how the Earth deforms	Jeri Y. Ben-Horin, Philip A. Pearthree
46	2:00pm - 3:00pm	Accommodation zones	James E. Faulds
	<b>3:00pm - 3:30pm</b>	<b>Coffee break and AGS book sales</b>	
47	3:30pm - 4:45pm	Geothermal systems and structural geology	James E. Faulds
48	4:45pm - 5:00pm	Preparation for field trip on Thursday with a map preview	Carson A. Richardson
<b>Day 10 28 March 2023, Tuesday</b>		<b>One-Day Field Trip on Brittle-Ductile Extension, Posta Quemada Wash, Rincon Mountains (or potentially Salcito Ranch area), and Final Dinner</b>	

6:45am	Assemble at front entrance of Marriott Hotel; pick up box lunch that is provided; be ready to depart for field trip at 7:00 am; drive east to Rancho Del Ceilo (Ruins)	Carson A. Richardson
8:00am	Arrive at Rancho Del Ceilo (Ruins). Distribute lunches, and hike 2 km up the wash, with walk-and-talk tour of key outcrops along the way	
9:30am	Mapping exercise along detachment fault contact	
11:30am	Lunch	
12:15pm	Continued mapping exercise, with groups slowly moving back towards vehicles and examining folds in Paleozoic hanging-wall rocks	
5:00pm	Return to Marriott Hotel; expected arrival at 6:00pm	
<b>6:30pm - 7:00pm</b>	<b><i>Cash bar, Canyon Room, Marriott</i></b>	
<b>7:00pm - 9:00pm</b>	<b><i>Final dinner, with certificates and flash drive with PDF of talks distributed</i></b>	

<b>29 March 2023, Wednesday</b>	<b>Check Out and Departure</b>
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6:45am	Short course attendees check out of Marriott Hotel and depart Tucson
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