ALASKA GEOLOGY

Newsletter of the
Alaska Geological Society

Recording the Aurora at Seismometers Across Alaska

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Across Alaska there are six all-sky cameras, 13 magnetometers, and >200 seismometers. The all-sky images and magnetometers have the same objective, which is to monitor space weather and improve our understanding of auroral activity, including the influence on magnetic fields in the ground. These variations in the magnetic field are also visible on seismometers, to the extent that during an auroral event, the long-period (40–800 s) waves recorded by a seismometer are magnetic field variations, not true ground motion. Although this is a problem, one that can be rectified with magnetic shielding at each seismometer site, it is also an opportunity because the present seismic array in Alaska is much broader than the coverage by magnetometers and all-sky cameras. Here we focus on three aurora events and document a direct link between aurora images in the night sky and seismometer recordings on ground. We also dive into the history of scientific discoveries in this realm, starting in 1716.

About the Speaker:

Carl Tape is a seismologist at the University of Alaska Fairbanks. He develops and applies techniques in computational and observational seismology to obtain better images of Earth's internal structure and to obtain better representations of earthquakes. Improved seismic images of the crust and mantle provide an important snapshot of a dynamic Earth, and they can be used for scenario earthquake simulations that help assess seismic hazard in earthquake-prone regions. Dr. Tape received his B.A. in physics and geology from Carleton College, a M.S. from Oxford University, and a Ph.D. from California Institute of Technology. He did postdoctoral research at Harvard University before starting as faculty at UAF in 2010.

AGS Meeting

Date & Time:	Thursday, November 19; doors open 11:30 am, announcements 11:45 am, talk 12:00 – 1:00 pm
Program:	Recording the aurora at seismometers across Alaska
Speaker:	Carl Tape, University of Alaska Fairbanks, Fairbanks, AK
Place:	Virtual online presentation
Reservations:	Reservations are not required
Login:	To log in to the presentation see the instructions at: http://www.alaskageology.org/events.html
How to Join:	Join with Google Meet meet.google.com/dyj-hzmw-fem or Join by phone (US) +1 641-715-7084 (PIN: 731731999)

From the President's Desk:

Last month, we kicked off a series of profiles with a brief review of Ruth Schmidt's work after the 1964 earthquake. This month we are profiling a geologist new to Alaska.

AGS would like to welcome Dr. Claudia Cannatelli to the Alaska geology community. Dr. Cannatelli will be arriving to Anchorage from Italy on November 13th as a new tenure track professor at UAA. Starting officially for the Spring 2021 semester, she will be teaching Mineralogy, Igneous and Metamorphic Petrology, Volcanology and will be in charge of the department's Spring seminar series. Please learn about the newest addition to our community below.

Andrew Dewhurst

Before we discuss your research interests, would you explain how you first became interested in geology?

The Italian territory is culturally and physically shaped by natural events such as volcanic eruptions and earthquakes. As an Italian I often felt the burden of living in a very seismically active area. My grandparents, originally born in a town close to L'Aquila had to relocate to Rome after the devastating 1915 Avezzano earthquake (M_s = 7.2, 31,000 victims), which completely destroyed their house and killed 90% of the population of their town.

During the last year of my undergraduate career in Physics, I decided to concentrate my studies on seismology. Etna volcano had just started a very unusual volcanic activity, and I was offered to collaborate with researchers from the INGV (National Institute of Geophysics and Volcanology), to install a mobile seismic network around the volcano. I already had the chance to visit a volcano before, such as Vesuvius in Italy or Timanfaya in the Canary Islands, but the field trip to Etna in 2002 was eye-opening for me. Upon graduation, I was the only selected student to attend the Internationalization Research Program "Internal Dynamics of Magmatic Systems of Active Volcanoes" between Italy (University of Naples – "Federico II") and USA (Virginia Polytechnic Institute and State University, Blacksburg, VA). My project involved the application of geophysics and geochemistry to investigate the role of fluids in the onset of magmatism and bradyseismic events in the Phlegrean Fields, a vast caldera located west of the city of Naples.

What areas of research or contributions would you like to highlight for the Alaska geology community?

My PhD studies led to several publications that shed light into the role of hydrothermal fluids in the onset of "slow" inflation and deflation of the ground (bradyseism) in the Phlegrean Fields. Furthermore, I provided for the first time an estimation of volatile contents in the magma that fed some of the explosive eruptions occurred in this volcanic field.

Phlegrean Fields is one of the most densely populated volcanically active areas in the world, located west of the city of Naples (Southern Italy), and affected by intense volcanism, hydrothermal activity and bradyseismic events. It is considered one of the highest risk volcanic areas on Earth, because of its three million inhabitants. The phenomenon of bradyseism (from the ancient Greek words "bradus", meaning 'slow', and "seism" meaning 'movement') has affected the area since Roman times, as testified by layers of boreholes left by marine mollusks on the marble columns of a Roman Temple in the area. The correct interpretation of a bradyseismic event is not just for academic interest, as the evacuation of large numbers of citizens caused (and continues to cause) financial, emotional, and physical stress on the affected population. Within the past 2,000 years, there have been many phases of ground movements in the area, and the only case documented of an event associated with uplift was the eruption of Monte Nuovo in 1538 A.D.

Although several authors proposed that the driving mechanism for the ground uplift at Phlegrean Fields can be attributed to an emplacement of magma at shallow depth, no scientific (petrological, geochemical or geophysical) evidence support such hypothesis. Our results suggest that in contrast with the other models, a hydrothermal model without magmatic recharge paints a better picture of the bradyseism phenomenon. Our data show that the fluid expelled by crystallization of pre-existing magma supplies the fluids involved in bradyseism, but the intrusion of new magma not play an active role in uplift episodes.

Parallel to the geophysics study, I contributed to the on-going scientific debate about the influence of volatiles on the equilibrium of phase of alkaline magmas, by geobarometric, thermometric and compositional determination of melts and co-existing volatile phases. I studied some of the most explosive eruptions occurred in the past 15,000 years in the Phlegrean Fields by using silicate melt inclusions. Silicate melt inclusions (SMIs) are small quantities of silicate melt trapped in minerals during their growth or crystallization. They contain liquids formed in equilibrium with their host minerals and therefore record the liquid line of descent of magmatic systems. Upon trapping, SMIs become ideally closed to the surrounding environment, and behave as time capsules, giving important information about processes that originated magmas and the nature of their mantle source. portant information about processes that originated magmas and the nature of their mantle source.

Our data allowed us to reconstruct the physical and thermodynamic properties of the magma(s) that originate some of the explosive events in the Phlegrean Fields. Assuming that isobaric fractional crystallization of a mantle-derived parental magma was the dominant petrogenetic process, we track major element evolution and corresponding changes. Parental magma was trachyandesitic, approximated by the composition of a melt inclusion from Fondo Riccio deposit (FR-C1-O2-M1), which evolved mainly through fractional crystallization at low pressure ($P \approx 0.15$ GPa, ≈ 7 km depth), along the QFM, QFM + 1 oxygen buffer with an initial dissolved H2O content of 3 wt%. The relationship between melt fraction and temperature reveals the presence of a pseudo-invariant temperature at which the physical properties of melt change abruptly. The net effect of these changes is to drive the system towards dynamic instability, which it is suggested to be the trigger mechanism for the eruptions.

Please see her 2020 publication for more information:

Cannatelli, C., 2020, Ground movement (bradyseism) in the Campi Flegrei volcanic area: a review, in De Vivo, B., Belkin, H.E., and Rolandi, G., eds., Vesuvius, Campi Flegrei, and Campanian Volcanism: Elsevier, p. 79-120, doi: 10.1016/C2018-0-00014-6

In addition to your teaching, what short-term goals do you have for your research in Alaska?

As I am arriving to Alaska in the middle of winter, for my first year I will not be able to fully conduct research on Alaskan volcanoes. I plan to go in the field in the summer 2021 and collect samples from Augustine volcano. I would like to shed some light into the volatile budget of magmas that have fed its eruptions, by using micro analytical techniques on melt inclusions.

What else about Alaska are you looking forward to? Do you like to ski, camp, hike, or fish?

I was born and raised under the Mediterranean sun, but LOVE to ski, I learned when I was 4 years old! I like backpacking, biking, hiking and camping, although I could not do these activities much in the past few years, due to the fact that I have a 7 year old boy and it becomes logistically complicated to organize any time outdoors! I went fishing once, didn't catch anything, but I would love to try there in AK!

What are some things that are important to you outside your professional/academic life?

When I am not working, I spend time with my family. We play games, make long walks, we ride our bikes, or I teach piano to my son (I have a degree at the Conservatory in Rome).

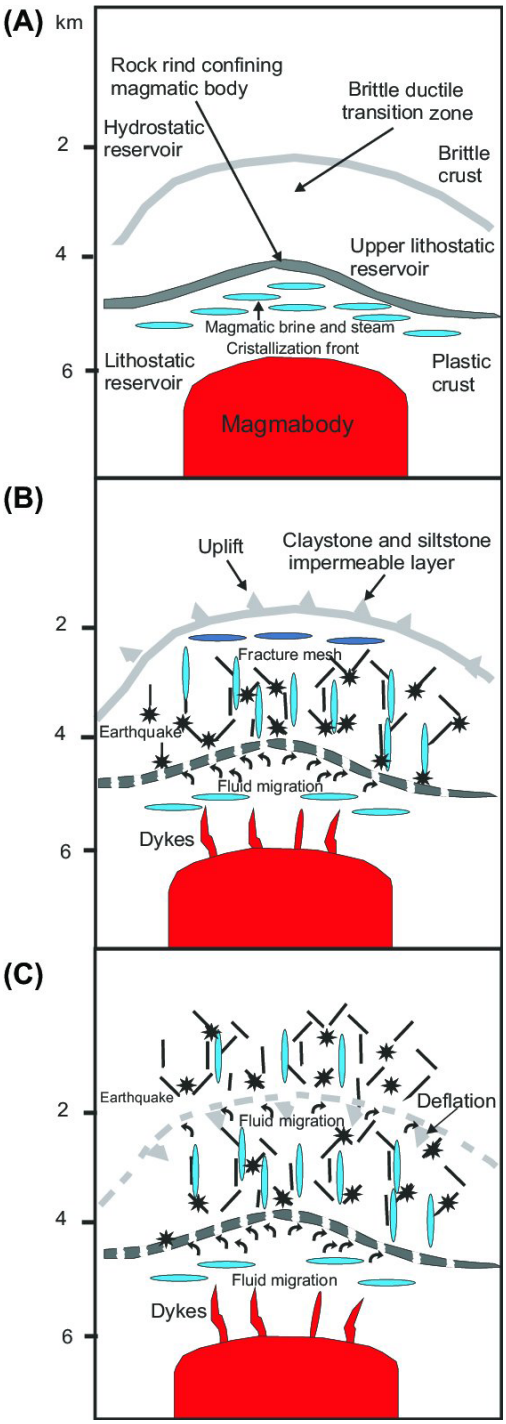


Figure 1. Caption: Schematic representation of magma, fluids, and crustal deformation at Phlegrean Fields. (A) Sealed magmatic-hydrothermal system showing the plastic and brittle domains separated by an intermediate lithostatic-hydrostatic reservoir. (B) The impermeable carapace confining the magmatic system allows magmatic fluids to enter the overlying rocks beneath the low-permeability cap rock, causing ground uplift. (C) Ground uplift ends and deflation begins when fractures penetrate the surficial low-permeability cap rock, allowing the fluids to migrate into the shallow aquifers and flow toward the surface.

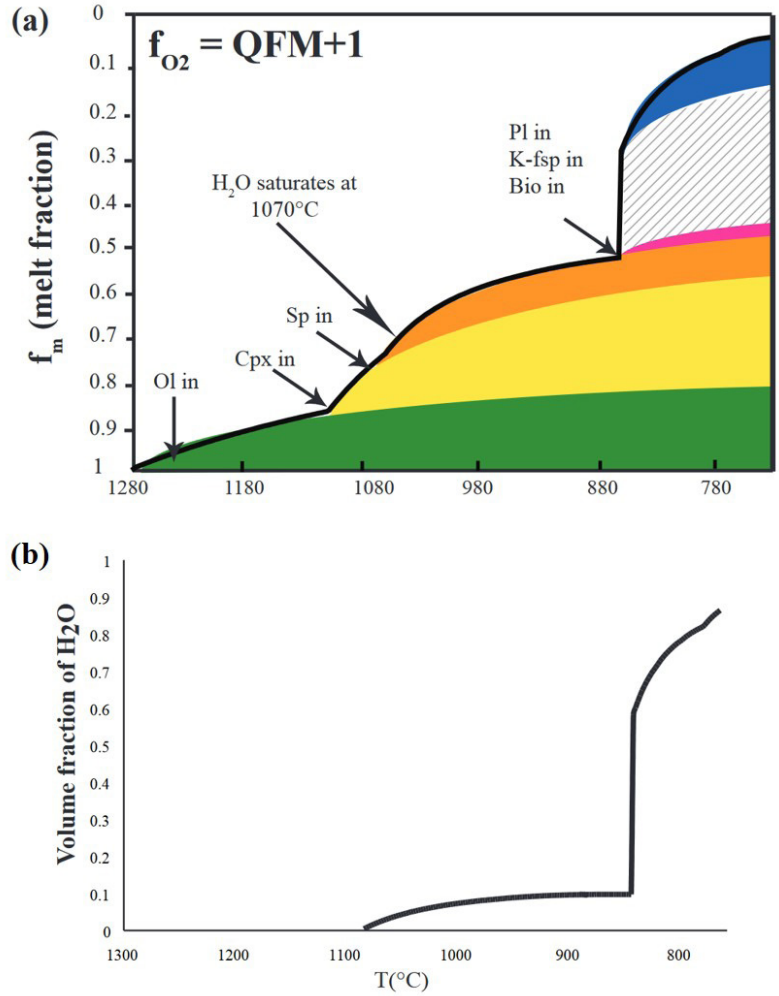
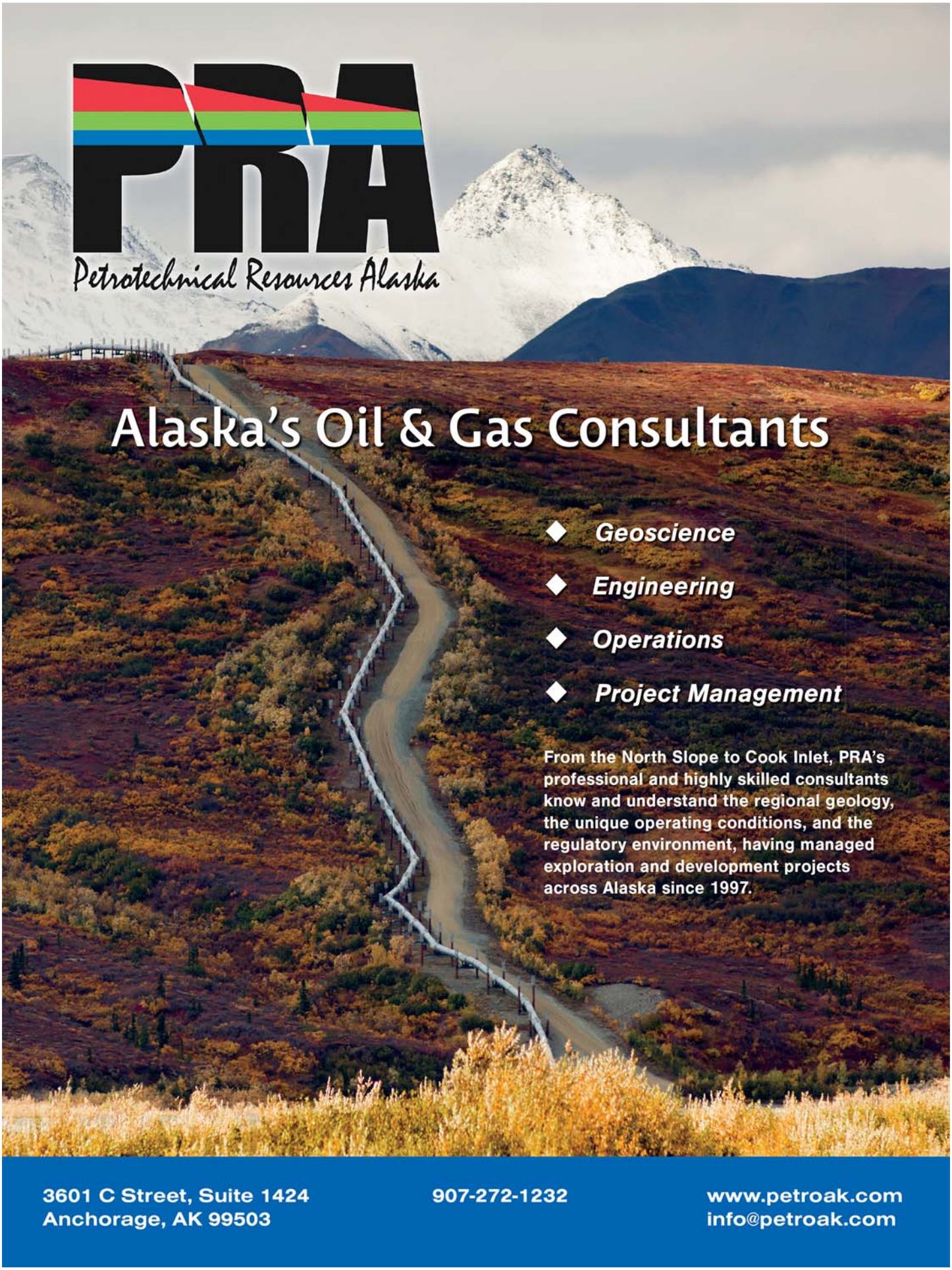


Figure 2. (a) Phase proportion diagrams as a function of temperature for MELTS simulation at QFM+1 oxygen fugacity, P = 0.15 GPa and H2O = 3wt%. Ap = apatite, Bio = biotite, Cpx =clinopyroxene, Ksp = alkali feldspar, Ol = olivine, Plag = plagioclase feldspar, Rh-ox = rhombohedral oxide, Sp = spinel. (b)Variation of the volume fraction of water along the liquid line of descent for the case P= 0.15 GPa, 3wt% H2O and QFM+1. H2O saturates at 1070°C.

Claudia and family at Ranu Kao volcano, Easter Island.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The Alaska Geological Society is an organization which seeks to promote interest in and understanding of Geology and the related Earth Sciences, and to provide a common organization for those individuals interested in geology and the related earth sciences.

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Contact membership coordintor Kirk Sherwood with changes or updates (e-mail: membership@alaskageology.org; phone: 907-334-5337)

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Alaska Geological Calendar of Events

Date	Time	Organization	Event	Location
Nov 19, 2020	11:45 am	AGS	Carl Tape, UAF, Recording the aurora at seismometers across Alaska	Google Meet
Dec 17, 2020	11:45 am	AGS	Steven Bergman, Retired, “Links between Phanerozoic Large Igneous Provinces (LIPs), Petroleum Systems, and Source Rocks”	Google Meet
Jan 21, 2020	11:45 am	AGS	Michael West, Alaska Earthquake Center, “The 2020 M7.8 Simeonof Earthquake and the end(?) of the Shumagin Islands Seismic Gap”	Google Meet
Feb 18, 2021	11:45 am	AGS	Elyse Gaudreau, University of Victoria, “Imaging active tectonics in the remote Brooks Range, Alaska: the 2018 Kaktovik earthquakes”	Google Meet
March 18, 2021	11:45 am	AGS	Brandon Browne, AK DGGS, Stratigraphic and petrologic aspects of a large (1980 Mt St Helens size) eruption from Aniakchak volcano 400 yrs ago	Google Meet
April 15, 2021	11:45 am	AGS	Palma Botterell, USGS, New North Slope oil geochemistry work	Google Meet
May 20, 2021	11:45 am	AGS	Robert Blodgett and others, various organizations, Jurassic arc rocks near Seldovia	Google Meet

AMA: Alaska Miners Association; **AGS**: Alaska Geological Society: **GSA**: Geophysical Society of Alaska

AAEP: Alaska Association of Environmental Professionals; **SPE** Society of Petroleum Engineers;
UAA University of Alaska Anchorage.

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