In This Issue...

Is Spring Earthquake Season?........................................Page 2
MESTA Officers & Representatives..................................Page 3
President’s Letter..........................................................Page 4
Thanks for the Honor....................................................Page 4
February Board Minutes ..............................................Page 5
MESTA @ MSTA.........................................................Page 9
Earthquakes: Rock Your Students World with
NGSS........................................................................Page 10
Locating an Earthquake Epicenter Using the IRIS
Station MonitorApp.......................................................Page 12
Outreach and Recruiting.................................................Page 15
Seismic Synopsis – Online Resources for Seismology....Page 16
History of the Creation-Evolution Controversy – Part 1....Page 17
Is Spring Earthquake Season?
By Cris L. DeWolf

In the context of American history, two of the most damaging earthquakes were the Great San Francisco Earthquake of 1906 and the 1964 Anchorage, Alaska earthquake. The 1906 quake occurred in the early morning of April 18th, and the 1964 quake in the late afternoon of March 27th. In terms of energy release, the moment magnitude (Mm) of the San Francisco earthquake is estimated to have been 7.9. The Anchorage quake had a moment magnitude of 9.2. Both of these earthquakes were powerful events with devastating impacts locally. The Anchorage earthquake was the second most powerful earthquake ever. It was only surpassed by the May 22, 1960 M9.5 Valdivia earthquake in Chile – also in spring! So, yes, at least in our school days memories large earthquakes seem to occur in the spring.

Digging deeper, and shifting our focus to global events, our memories are at fault. Earthquakes have no seasonal trend. Of the twenty largest earthquakes ever recorded, only five were in the spring. Nine occurred in the winter, three in the summer, and three in the fall. While at first glance it looks like winter is a favored time for strong earthquakes – this is northern hemisphere winter. Five of the “winter” earthquakes occurred in the northern hemisphere, three near the equator, and one in the southern hemisphere.

Also, our historical record provided by the USGS for the “20 Largest Earthquakes in the World” only goes back to 1906. Hardly a comprehensive listing for all of human history – let alone geologic history! An even deeper dive into historical accounts lists many more powerful earthquakes including the 1556 Shaanxi, China earthquake, widely reported as the deadliest earthquake in human history. Over 830,000 deaths are reported. A timeline of these events is provided by the United States Geological Service (USGS) at https://earthquake.usgs.gov/learn/topics/eqsci-history/eqscience-timeline.php.

While no specific dates are provided here, by doing some additional investigation online you will find they are scattered through the year. So, we can safely say that there is no seasonality with powerful earthquakes, and just hope we never have a repeat of the “Bad Friday” of 1964.

MESTA sponsors MIQuakes, a regional network of educational seismographs placed in schools around Michigan. Our network is a subset of the broader “Seismographs in Schools” program of IRIS – the Incorporated Research Institutes for Seismology.

Over the course of 2019 we will be planning for future growth of the network. Work is progressing on repairing/restoring retired sensors and on the transition to the new software – jAmaSeis.

Our spring issue has a geology theme – with a focus on seismology. Resources available from both IRIS and the USGS will be featured on the following pages.

Enjoy, and welcome to spring!

Data source: https://earthquake.usgs.gov/earthquakes/browse/largest-world.php

Cover Image: Downtown Anchorage after the M9.2 Good Friday earthquake, March 27th, 1964
MESTA Officers & Representatives

Executive Committee

President
Lisa Bouda (Grosse Pointe Woods, MI) v313-432-5260
Bouda90@comcast.net

Past President/NESTA Contact/Rock Shop Chair/
E-News Editor
Parker Pennington IV (Ann Arbor, MI) h734-623-7245
p.o.pennington@gmail.com

Treasurer
Andrea Williams (Grand Blanc, MI)
williamsa@westbloomfieldk.12.mi.us

President-Elect
Peter Voice (WMU)
peter.voice@wmich.edu

MES Editor/Stoney Award Chair
Cris DeWolf (MeCosta, MI) w: 989-967-2167
dewolf.cris@gmail.com

Membership Chair
Ardis Herrold (AZ)
amacio@comcast.com

Recording Secretary
Carrie Cook (Flushing, MI)
ccook@lindenschools.org

Governing Board

Public Relations Chair/Professional Development
Co-Chair
Sherry Claflin (Fremont, MI)
lsciaflin@gmail.com

Cranson Field Scholarships Chair
Kevin Dehne (Saginaw, MI) w: 989-686-9326
ktdehne@delta.edu

Historian
Rod Cranson (Lansing MI) h: 517-321-2473
rcranson@sbcglobal.net

MSO Liaison
Sheila Swyrtek (Mott CC)
Sheila.swyrtek@mcc.edu

Kit Coordinator/ Professional Development
Co-Chair
Maria Gonzalez, mgonzalez@hfsgb.org

MSTA Liaison
Tim Neason (Caledonia, MI) c616-260-9681
tneas326@chartermi.net

F&I Chair
Chuck Schepke (Roscommon, MI)
schepkec@gmail.com

Meteorology Liaison
Dave Chapman (East Lansing MI) w: 517-351-7900x3186
chapmand@okemossschools.net

New Teacher Contacts – OPEN

OEST Award Chair/Raffle Chair
Jay Sinclair (Milan MI) w: 734-269-2220
sinclair.jay@sbcglobal.net

Volunteer Coordinator
Mike Bause (Highland MI) w: 248-785-2005
mike.bause@farmington.k12.mi.us

Website Coordinator
Jack Hentz (Rosenberg TX)
jwhentz@sbcglobal.net

At Large Governing Board Members

Bill Dicks (Novi, MI)
bcd1200@hotmail.com

Kathleen Sparling (Flushing, MI)
k-sparkles@comcast.net

Dave Thomas (Canton MI)
dthomas@wccnet.edu

Reggie Mulligan (Retired)
rmuligan75@gmail.com

Judy Ruddock (Retired)
rduddock6412@gmail.com

Tabby Eldridge
tabby447@hotmail.com

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Items to be considered for publication should be
sent to the editor at dewolf.cris@gmail.com.

Microsoft Word documents in Times New Roman
10 are the preferred format. Any images should be
sent as a separate jpeg file.

Deadlines for submissions are:
Winter – December 21st
Spring – March 21st
Summer – June 21st
Fall – September 21st
President’s Letter, March 2019

As an Earth Science Educator, one of our jobs is to break misconceptions that students come to us with. Below you will find 5 misconceptions about earthquakes that I have found in my classroom. I hope that you can find some useful information that you can use in with your students.

1. **An earthquake is a very rare event.** Most students believe that earthquakes happen only 1-2 times per year. In reality, hundreds of thousands of earthquakes happen every year. But only the major events that affect the US seem to make the mainstream media. An excellent way to show this to students is to have them download an earthquake app. I like “QuakeFeed” available for iPhones, but there are many free apps available. A list is given of all earthquakes from the past several days. After looking at this app, students are surprised about the number of earthquakes that have happened each day. I also use this app to have students plot earthquakes on a world map according to the depth of the focus. Students can also be notified of earthquakes. I suggest to set the notification to 6.0 magnitudes or higher, otherwise you may get alerts for every small earthquake on the planet. Before you know it, your students will be notifying you of recent earthquakes.

2. **The epicenter is located where there is the most damage.** What if it’s a minor quake or it happened in the middle of nowhere? Damage doesn’t always equate to where the fault ruptured. For years I have used the program “Virtual Earthquake” to have students find the epicenter from seismograph data. Much to my surprise, that program is no longer available. So I am back to finding the epicenter using drawing compasses and paper. From the lag time between P and S waves, students calculate the distance of the epicenter. Then they triangulate from 3 different seismographs to find the intersection, that’s how the epicenter is located.

3. **California is the only place in the US to experience earthquakes.** Trivia question: Where was the largest earthquake ever recorded in the US? Answer: Anchorage Alaska, 1962, 9.2. Most students know that the San Andreas Fault runs through California. But they don’t realize that Portland Oregon, Seattle Washington and Alaska are earthquake prone areas too. In addition, there are plenty of intraplate earthquakes in the US. The New Madrid earthquakes of 1811-12 were severe enough to ring church bells in Detroit. Michigan is no stranger to earthquake either. Most recently, students in my community felt the Amherstburg, Ontario earthquake that occurred in April of 2018. A list of epicenters in Michigan can be found at: [http://aroundmichigan.com/2018/04/15/history-earthquakes-michigan/](http://aroundmichigan.com/2018/04/15/history-earthquakes-michigan/)

4. **Scientist can predict earthquakes.** Scientist can (usually) predict WHERE earthquakes happen, but not WHEN they will happen. This is a fascinating area of research. Some of the research is about precursor quakes. Some research is being done for sensors to register the P wave and shut down things like gas mains before the more destructive S wave hits. Others rely on the sensitivity of animals (especially toads) to forecast an earthquake. But none of these methods seem to have the repeatability factor to make them reliable. So, for now, predicting when earthquakes occur is not possible.

5. **Richter scale is the scale used for measuring earthquakes.** There are several scales to measure earthquakes. The Mercalli scale measures the intensity of the ground shaking and will vary based on the observer’s distance to the epicenter. The moment-magnitude scale has replaced the Richter scale. Richter developed his scale in 1935, and it was not accurate for large quakes. Thus, the moment magnitude scale took the place of Richter. This scale uses a formula and seismograph to more accurately describe the energy released by an earthquake. Even though the media may report a Richter scale magnitude for recent quakes, most likely it is the moment-magnitude scale.

Lisa Bouda, MESTA President

Thanks for the Honor

Sharon and I really enjoyed the Michigan Earth Science Teachers Association Awards Banquet on March 1 in Grand Rapids. My selection to receive the 2018 Outstanding Michigan Earth Science Teacher of the Year Award was a distinct honor. Being included among the many outstanding Earth Science Teachers was a high point of my career. I appreciate this honor- thank you. In reflecting back over the 50+ years I have been associated with M.E.S.T.A., it always amazes me of its impact on education across Michigan and beyond. Our guiding philosophy of volunteer service by earth science teachers seems such an unlikely expectation. It speaks to a special group of people to make an organization like M.E.S.T.A. function - how unique is that?

Rod Cranson
I am very humbled to have been selected by the Michigan Earth Science Teachers Association and the A. E. Seaman Mineral Museum of Michigan Tech to receive the Charles A. Salotti Earth Science Education award. Martha and I were very moved by the many kind words that were expressed at the ceremony. My involvement with Mesta and IRIS (under which MIQuakes was initiated), have been the highlight of my academic career. My first introduction to Mesta was in 1982 when Stoney encouraged me to write for the Michigan Earth Scientist, but it was not until 1998 when I started attending board meetings that I realized the extent of the contribution that you have made to all aspects of Earth Science teaching. Over the past 25 years, I have not only enjoyed working with Mesta, but I have also learned a great deal from you through those interactions. As I enter retirement, I hope I can continue to contribute to Mesta’s tradition of “teachers helping teachers” and the honor you have graciously bestowed.

Kaz Fujita

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**Mesta Board Meeting**

**February 9, 2019**

Members in attendance: Lisa Bouda, Cris DeWolf, Andrea Williams, Jay Sinclair, Parker Pennington IV (Via Zoom), Kevin Dehne, Carrie Cook, Ardis Herrold. (Via Zoom), Chuck Schepke, Dave Chapman, Tim Neason (Via Zoom), Jack Hentz (Via Zoom), Kathleen Sparling, Sheila Swyrtek (Via Zoom), Sherry Claflin, Maria Gonzalez

**Saturday – February 9, 2019: 4835 Schneider St, Saginaw, MI 48638**

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<thead>
<tr>
<th>Time</th>
<th>Topic</th>
<th>What We are Doing</th>
<th>Notes / Discussion Points / Actions to Be Taken</th>
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<tr>
<td>5 – 10 min</td>
<td>Review Agenda / Last Board Minutes</td>
<td>Discuss</td>
<td>Cris moved to approve minutes from September agenda. Dave C. seconded it. Agendas were approved unanimously. December board minutes were approved electronically. January Executive Board meeting minutes need to be approved. (approved during lunch)</td>
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<tr>
<td>10 min</td>
<td>Rock Shop (Parker)</td>
<td>Discuss / Recommended Action</td>
<td>The next GLW shopping days are: April 5-6-7, 2019 July 12-13-14, 2019 October 4-5-6, 2019 Rock Shop schedule MSTA in Grand Rapids March 1-3, 2019 (Andrea W., Cris D.) Jay S. Parker P. Chuck S. Sherry C. Bill D.) 4:30 ish is potential time for set up. Kevin moved to get 2 fleeces and two hats for awardees. Andrea seconded. Motion Carried unanimously. MSO State tourney Saturday April 27, 2019 (Lisa B. Andrea W. Cris D. [2] Jay S. Parker P. Bill D. Sherry C., Sheila) (Possible work session to prep fossils for MSO (tie to MSO fossil list—bag &amp; label bulk fossils)</td>
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<td>5 min</td>
<td>Treasury (Andrea)</td>
<td>Discuss / Recommended Action</td>
<td>Copy of treasury annual report can be found in Google Drive. There was a loss of around $3000 from previous year, due to charitable donations and grants. Andrea will send out a link to the board.</td>
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<td>5 min</td>
<td>Stoney Grant (Cris)</td>
<td>Discuss / Recommended Action</td>
<td>Dave C. moved that we support the Stoney Grant for the Advanced Geology class. Chuck seconded the motion. The vote passed unanimously to award this grant. Cris will contact the Stoney Grant awardee with information about the conference. Cris will try to make a Google Form or Doc to help applicants complete the application online. There is money from the national level to award Stoney Grants. Parker recommended that there be someone to help promote and coordinate the process through the NSTA award committee. Jay volunteered to help promote the Stoney Grant at the national level. Cris volunteered to help Jay.</td>
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<td>5 min</td>
<td>NESTA Report (Parker)</td>
<td>NESTA will have a Share-a-thon, and Rock Raffle in conjunction with the Ohio ESTA—as well as other ES sessions at the NSTA Area Conference in Cincinnati: Nov. 14–16, 2019. Jay, Cris, and Parker are planning to attend. NESTA is sponsoring a Costa Rica summer field conference. Flyer was sent to the Board Listserv</td>
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<td>Membership (Ardis)</td>
<td>Discuss / Recommended Action</td>
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<td>I have been working with Carla (NESTA Exec. Director) and Parker to research transferring our membership and related services to another platform. Wild Apricot seems to be the best one out there in terms of ease of use, pricing, and range of services. Some of the services it offers: website hosting, automated renewal notices, tagging for different types of memberships (such as free, Life, etc), registration for events, merchant account hosting, online payments, and of course, a friendly membership. Members can update their own information, and it is mobile friendly. Parker has spoken with Comerica about what it would take to set up a merchant account. Right now, we have about 190 members in good standing, and 363 expired members. Wild Apricot costs $45/month if it is prepaid on an annual basis and the membership stays under 250. The next price break is $81/month for 500 members. Outstanding issues: how do we send out the E-News to members (which now is spawned from the list on the NESTA database and is horridly out of date), and how do we integrate the new listservs? Breaking news: NESTA now appears to have a Wild Apricot account and I am not certain if it is even in use right now. It may be possible for us to use the NESTA account to launch our new membership services. I will follow up with Carla, Parker and Howard Dimmick to check on this. NESTA plans to transfer its membership services into something like Wild Apricot as soon as it is released from its contract with SUNY, but that is still several years off. Dave made a motion that Ardis try to see if we can get the Wild Apricot from NESTA for free on trial basis, but if not, to empower her to go ahead and get the service for a year. Ardis seconded the motion. Motion unanimously passed.</td>
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<th>10 min</th>
<th>OESTA / Salotti (Andrea/Chuck)</th>
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<td>Awards dinner to honor 2018 OESTA winner is in the works and scheduled for Friday, March 1st in Grand Rapids (in conjunction with the MSTA conference) - No nominees for 2019 submitted at this time. - HELP! Andrea will have fliers and applications at MSTA, as well as send out an advertisement on the ListServ.</td>
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<th>Kits (Maria)</th>
<th>Discuss / Recommended Action</th>
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<td>The idea behind the kit is a basic egg-carton rock kit for elementary teachers that are not strong on geology. There would be a Google Doc or Folder on Google Drive to share lesson plans or activity ideas. Ardis recommended that we put the kits together so that we have class sets of the rocks, instead of one egg carton of rocks. This would help with exploration, and would entail ziploc bags with multiple of the same sample in it. Ardis also suggested that the kits be broken up into metamorphic, igneous, and sedimentary. Going to start off with a few kits, @20-30 of them. Looking for any spare samples of the following rocks: - granite - gabbro - basalt - rhyolite - shale - sandstone - fossiliferous limestone - chert or gypsum - marble - quartzite - slate - schist or gneiss Also, I am looking for suggestions of pricing. I am figuring to keep it on the inexpensive side of pricing. Andrea suggested we advertise the workshop for the kit at MSO. Chuck recommended</td>
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that this kit and lessons be presented at a conference. Maria will communicate will collect donations for the kits at board meetings and conferences prior to October.

| 5 min | Field Trip 2020 (Kevin) | Discuss/ Recommended Action | There are no ideas at the moment. Southwest Astronomy.....?  
Kevin is looking for ideas. Bring them to the next board meeting. |
|-------|-------------------------|-----------------------------|------------------------------------------------------------------|

| 15 min | Cave Geology Field Trip (Dave C.) | Discuss/ Recommended Action | Dave went over the itinerary for the field trip.  
Issues:  
1. Food - Can the people who stay at the facility make meals? Especially breakfast. This would save time and money. Kevin and Sherry said that they would be willing to be in charge of two of the breakfasts. We are looking to have two dinners at the facility. One bring in outside food, and the other cook. Cost for trip per person is around $125.  
2. Scheduling activities: Offer times for people to do things on their own. Distillery will have to be scheduled as a group tour. Refunds? When will money be due?  
Registration needs to be created for MSTA. Things to add to the registration:  
  ● RV or Not  
  ● Family or Not  
  ● Interest in options for free day  
  ● Dietary concerns  
  ● Limited Space  
  ● MESTA members or family members only. |
|-------|-------------------------|-----------------------------|------------------------------------------------------------------|

| 10 min | MESTA (Dave, Peter, Sherry) | Discuss/ Recommended Action | It looks like the best dates for our fall conference will be October 4 and 5. We have Mona Shores middle school for our venue on Saturday thanks to Matt Schugart. On Friday, I have GVSU Annis Water Resources Institute for 2 Research vessel trips to do water quality testing in Muskegon Lake and Lake Michigan (weather contingent for Lake Michigan) each trip is 2.5 hours. (Times are flexible, but suggested 9:30 to 12 and 1 to 3:30. Boats can hold 28 max.) Cost TBD.  
Using AWRI for lunch in the Multipurpose room on site. I have contacted the wastewater facility for a tour on Friday morning, October 4. We can also do a Dune study along the shoreline in the pm opposite the research vessel at PJ Hoffmaster State Park or Muskegon and Duck Lake State Parks. This will allow people who do not want to go on the boat trip both a morning and afternoon activity. I’d like to talk about where you would like to hold the Friday evening awards - dinner. I’d like to hold it at the Observatory - basically in the Barn and open the Observatory for viewing after the dinner as an additional fun activity for people. I know this doesn’t match the water theme we are going with, but it is another activity that people may enjoy. Or we could hold it at Mona Shores.  
I am also in the process of contacting AGU for Earth Science Week toolkits. Since our conference will kick off Earth Science week 2019, it might be really cool to give everyone the toolkit as part of their registration.  
F&I and raffle will be there.  
Sherry was given some suggestions to modify the flier for distribution at MSTA.  
We need a keynote speaker for lunch on Friday. Maria will have a kit workshop at the conference. We need to get some presenters for the workshop. We also need to have an itinerary. |
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<td>10 min</td>
<td>MSO (Sheila)</td>
<td>Discuss/Recommended Action</td>
<td>Do we want to donate money to MSO or have a volunteer to donate time? Volunteers would need to be there for just the day. They can sign up to volunteer online for specific events, usually just to score the event. Lisa and Maria are volunteering their time to help for half the day. Sheila will put together another blurb for the E-News to try to get more volunteers for this event.</td>
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<td>10 min</td>
<td>NESTA Listserv (Parker)</td>
<td>Discuss/Recommended Action</td>
<td>Parker recommended that people already on the NESTA boards with the appropriate account be the ones that will manage the listserv. (Parker, Jay, and possibly Ardis). Seems that this will possibly be a smooth transition. This will have to occur before Carl retires. Please RSVP to the Doodle poll regarding your email addresses on the Officer page! If you have not done so.</td>
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<td>5 min</td>
<td>Fish Lake Field trip (Kevin)</td>
<td>Discuss/Recommended Action</td>
<td>Fish Lake - July 26 - 29th. Cost $68. Add to MESTA calendar and to Facebook page.</td>
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<td>5 min</td>
<td>MSU liaison (Lisa)</td>
<td>Discuss/Recommended Action</td>
<td>It was suggested that this position be eliminated or the title changed to College Liaison. Danita Brandt is interested in being a liaison for MESTA from MSU, but does not wish to be an official board member. It was decided that we would retire the official MSU Liaison position with Kaz and welcome Danita as a MSU Liaison, invite her to board meetings, but not have her officially on the board.</td>
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<td>5 min</td>
<td>Board Minutes Approval (Lisa)</td>
<td>Discuss/Recommended Action</td>
<td>An electronic poll will be sent out 2 weeks after the minutes are published for approval. Approval of minutes will be included in the next board meeting minutes. Tentative approval = Doodle Poll Official approval = Board Meeting Executive Board approved minutes for January 2019. It was approved that we would Subsidize the awards dinner at the MSTA conference.</td>
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<td>5 min</td>
<td>NSTA Climate Statement (Parker)</td>
<td>Discuss/Recommended Action</td>
<td>It is recommended that in the future we go through the proper procedure to add things like the Climate Change Statement from NSTA. Jack will take it off the website until we have further discussion.</td>
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<td>5 min</td>
<td>NESTA Stoney Awards (Parker)</td>
<td>Discuss/Recommended Action</td>
<td>See Reports Above</td>
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<td>5 min</td>
<td>Setting Dates for 2020 (Lisa)</td>
<td>Discuss/Recommended Action</td>
<td>We will do this at the May meeting. Please bring important dates (GLW, NSTA regionals) with you to this meeting and put them on the MESTA google calendar. Cris will restrict the edit access to Google Calendar to Jack, Lisa, and himself. Please send additions to those folks with edit rights or bring to the board meetings.</td>
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<tr>
<td>Upcoming Dates</td>
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<td>Mar. 1 Special Award Banquet&lt;br&gt;March 1-2 MSTA Conference, Grand Rapids&lt;br&gt;April 27 MSO State tournament- Michigan State University&lt;br&gt;May 4 Board Mtg. - Fish Lake&lt;br&gt;July 26-29 Fish Lake field trip&lt;br&gt;Aug. 10-13 MESTA cave field trip&lt;br&gt;Oct. 4-5 MESTA Conference Mona Shores/Muskegon area</td>
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Motion to adjourn - Kathleen<br>Seconded - Maria<br>Unanimously passed.<br>Meeting Adjourned at 2:00 pm
MESTA @ MSTA

If you did not attend the 2019 Michigan Science Teachers Association conference, you missed a great event! With the conference being held in Grand Rapids this year, we were fortunate that it landed on a weekend lacking any significant weather events. Being from the Grand Rapids area originally myself, I always enjoy the opportunity to return. Sorry east siders….

MESTA offerings this year included Rock Shop, Rock Raffle and the return of Free & Inexpensive. Chuck Schepke brought a selection of low-priced rocks and minerals that have been donated by MESTA members. I thank him and the rest of you who donated materials to make this possible. Showstopper demonstrations were a feature of this year’s conference as well, with Kevin Dehne dazzling the crowd with his cloud-in-a-bottle expertise and Dave Mastie sharing the many things that you can do with potatoes.

My wife and I continued our work on providing NGSS activities for elementary teachers with this year’s “Earthquakes: Rock Your Students World with NGSS!” . Our session was well attended, with more teachers wanting to join us than the room would support. I see a real need here for us to serve, and challenge you to meet this need with sessions of your own at future conferences. A complete 5E lesson plan from our session is included in this issue of the MES.

Two members were recognized at our annual Awards Banquet this year. We met Friday night, March 1st, at Forty Pearl for dinner and conversation – and presentation of our Outstanding Earth Science Teacher Award and the Charles A. Salotti Earth Science Education Award (Seaman Mineral Museum).

Rod Cranson, one of the “founding fathers” of MESTA, and frequent contributor to the Michigan Earth Scientist, was the recipient of this year’s OEST Award. In fact, in recognition of his years of service to Earth Science Education, his award was called the “Outstanding Earth Science Teacher of the Cenozoic Era” award.

Kazuya Fujita (Kaz) was the recipient of this year’s Charles A Salotti Earth Science Education Award. This award is sponsored by the A.E. Seaman Mineral Museum and is awarded to those who show significant contributions to informal education efforts. Kaz has certainly done so, by hosting numerous workshops on seismology for teachers, as well as working with Lansing area elementary students. He has been instrumental in supporting our teacher outreach for MIQuakes – our regional educational seismograph network, helping establish this project under the broader umbrella of the Incorporated Research Institutes for Seismology (IRIS).

Also announced at the conference was this summer’s field trip to Mammoth Cave, Kentucky. This trip will be in August, from the 10th through the 13th. A tentative itinerary is listed on our website – www.mestarocks.org. This looks like a fantastic trip, and will be led by two of our members, Dave Chapman (Okemos H.S.) and Lisa Bouda (Grosse Pointe South H.S.), who have done similar trips with their high school students. We also offer assistance with funding these trips through our Cranson Field Scholarship program. Applications for this are also found on our website.

Have a great spring!
Cris L. DeWolf, MES Editor
Earthquakes: Rock Your Student’s World with NGSS!
*From the 2019 MSTA Conference, Cris & Lisa DeWolf – Presenters

Earth is a dynamic planet. Geological processes impact human activity in many ways. The release of stored energy accumulated along faults due to movement of the planet’s tectonic plates causes earthquakes. The resulting damage from these events has immediate personal impacts as well as longer lasting economic impacts. To limit the consequences of geohazards such as these, solutions are sought through the engineering design process. In this activity, your students will design and test structures to evaluate their ability to remain standing following an earthquake. The lesson is designed around the 5E model, which was developed by the Biological Science Curriculum Study (BSCS) as an instructional model for constructivism, a process where learners build an understanding of new concepts through engagement in inquiry.

Engage
Read passages from “Can You Survive an Earthquake” (Rachel Hanel, ISBN-10: 9781620657096) or another book in the recommended readings list under resources. Discuss the dangers of earthquakes with your students. Show your students the YouTube video “Earthquakes for Kids: A fun engaging introduction to earthquakes and tsunamis for kids” (a National Geographic production via Clarendon Learning) using this link: https://www.youtube.com/watch?v=Q-v-G1iL6?w. Discuss the damage that can result – especially collapse of structures such as highway overpasses and building. Lead your students towards wondering “How can buildings be designed (built) so that they can withstand shaking from an earthquake?”

Explore
Show the YouTube video “Why do buildings fall in earthquakes?” https://www.youtube.com/watch?v=H4VQul_SmCg. Introduce the design challenge – “Design a building that is at least 4 stories tall that will withstand 30 seconds of shaking on our shake table.” The students’ solution will have the following constraints: the building must be 4 stories tall, using only the materials provided (36 short toothpicks, 8 long toothpicks, and 20 marshmallows or small Styrofoam balls). The tower should be secured to a cardboard base with dimensions twice that of the tower base.

Students will design and test a structure that conforms to the constraints of the engineering design task in small groups. Observations should be recorded in their notebooks, to be used in the next step of this lesson.

*Two shake tables were used in the presentation at the Metropolitan Detroit Science Teachers Association. Their effectiveness at simulating actual earthquakes were evaluated. One is a commercially available “game” – Smartlab Toys Aftershock Earthquake Lab set. The other was built using instructions on this “Juicy Geography” website: https://drive.google.com/drive/u/0/folders/1fPd-Eap3x1lPl546FzzpzatbuDOehil?ogsrc=32. When using the “homemade” shake table, the teacher should be the one doing the shaking so that all groups experience the same level of shaking. Some practice with a pre-built structure will be needed to determine a useful level of shaking for this lesson.

Explain
* Students will discuss the results of their tests after viewing “How we design buildings to survive earthquakes” (https://www.youtube.com/watch?v=c4fKBGsllZI). They then design solutions to building failures using information presented in the videos. Explanations (using key terms/ideas from the video) of why their buildings failed should be written in their notebooks.

Elaborate
Students incorporate their design changes into new structures and retest them on the shake tables. They should write down their observations of any improvement in survival of the structure. They may go back and consider new changes should it fail to do significantly better than the first design.

Evaluate
A mini-poster is prepared by each group to use in a gallery walk showcasing what they learned about designing buildings for earthquake resistance.

Resources
Connecting to the Next Generation Science Standards (NGSS Lead States 2013)

**Standards**

4-ESS3 Earth and Human Activity


3-5-ETS1-2 Engineering Design

https://www.nextgenscience.org/pe/3-5-ets1-2-engineering-design

**Performance Expectations**

4-ESS3-2

Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans

* [Clarification Statement: Examples of solutions could include designing an earthquake resistant building and improving monitoring of volcanic activity.] [Assessment Boundary: Assessment is limited to earthquakes, floods, tsunamis, and volcanic eruptions.]

3-5-ETS1-2

Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

<table>
<thead>
<tr>
<th>DIMENSIONS</th>
<th>CLASSROOM CONNECTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science and Engineering Practices</td>
<td></td>
</tr>
<tr>
<td>Constructing explanations and designing solutions</td>
<td>Students will collaborate to design a plan for their building. They will build the structure and test it on the shake table. If needed, they will modify their structure until it is able to survive the earthquake.</td>
</tr>
<tr>
<td>Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems.</td>
<td></td>
</tr>
<tr>
<td>* Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design problem.</td>
<td></td>
</tr>
<tr>
<td>Disciplinary Core Ideas</td>
<td></td>
</tr>
<tr>
<td>ESS3.B: Natural Hazards</td>
<td>Students research earthquake-resistant buildings by watching these YouTube videos:</td>
</tr>
<tr>
<td>* A variety of hazards result from natural processes (e.g., earthquakes, tsunamis, volcanic eruptions). Humans cannot eliminate the hazards but can take steps to reduce their impacts. (4-ESS3-2) (Note: This Disciplinary Core Idea can also be found in 3.WC.)</td>
<td></td>
</tr>
<tr>
<td>ETS1.B: Designing Solutions to Engineering Problems</td>
<td>Students design and test a structure, revising their design if needed.</td>
</tr>
<tr>
<td>* Research on a problem should be carried out before beginning to design a solution. Testing a solution involves investigating how well it performs under a range of likely conditions.</td>
<td></td>
</tr>
<tr>
<td>* At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs.</td>
<td></td>
</tr>
<tr>
<td>Cross Cutting Concepts</td>
<td>Students use journaling to explain how their designs decrease personal risk and cost to society of building collapse due to earthquakes.</td>
</tr>
<tr>
<td>Interdependence of Science, Engineering, and Technology</td>
<td></td>
</tr>
<tr>
<td>Knowledge of relevant scientific concepts and research findings is important in engineering. (4-ESS3-1)</td>
<td></td>
</tr>
<tr>
<td>Influence of Engineering, Technology, and Science on Society and the Natural World</td>
<td></td>
</tr>
<tr>
<td>* Over time, people’s needs and wants change, as do their demands for new and improved technologies. (4-ESS3-1)</td>
<td></td>
</tr>
<tr>
<td>* Engineers improve existing technologies or develop new ones to increase their benefits, to decrease known risks, and to meet societal demands. (4-ESS3-2)</td>
<td></td>
</tr>
</tbody>
</table>
Locating an Earthquake Epicenter Using the IRIS Station Monitor App

Having our students locate an earthquake epicenter has been a “traditional” activity done in classrooms for years. Typically, it is an activity pulled from a workbook or off a website that uses “canned” data. Wouldn’t it make the lesson more relevant to your students if you could build it around a recent earthquake that had a direct impact on your country? The strong earthquake that occurred November 30th, 2018, near Anchorage, Alaska, provided an excellent opportunity to show my students how triangulation is used to locate an earthquake epicenter.

The Incorporated Research Institutes for Seismology (IRIS) has an extensive array of educational resources for teachers. In addition to supporting networks of educational seismometers – including Michigan’s MIQuakes network – IRIS has a new app called Station Monitor. This app is available for both iOS and Android devices. It also can be run on desktop computers with Internet access. The activity presented here is based on the desktop version of Station Monitor. It can be accessed at this URL: https://www.iris.edu/app/station_monitor/.

When you visit the website, you can select a region of interest by clicking on the global map image shown on the home page. Each click on the map zooms you in closer on specific regions.

When you have zoomed in sufficiently to identify individual stations in a state, like Michigan, pick one. For this lesson I chose to work with one closest to me in Sunmer, MI. You will see a screen like that shown below.

You are able to select events from a list displayed on the screen, or you can select a date of interest – if you know when an earthquake occurred. The Anchorage earthquake is listed in the recent events pane. When you select that event the program displays the seismogram for that day, with a magnifying glass tool labeled “Click Me” at the beginning of the record for the earthquake. When you click it, you get a more detailed seismogram of the event. Arrival times for the P and S waves are marked on the seismogram, time of occurrence at the epicenter, depth, distance from the epicenter to the station (Sunmer), and magnitude are all provided. Links to various sites for more information, as well as an interesting link to a sound file are also provided.
In addition to the Sunmer, MI station, I also selected stations at Belgrade, NE, Marconi Conference Center, San Francisco, CA, and Seward Park Seattle, WA to have my students use to triangulate the location of November 30th earthquake.

Provide your students with just the seismogram with P and S arrivals marked and have them estimate the arrival times for each. These are shown here.
Your students will need to calculate the difference between the arrival times of the P and S waves and use this with the travel-time curves graph to determine the distance from each station to the epicenter of the earthquake. The table below shares what my students came up with for this.

<table>
<thead>
<tr>
<th>Station Name</th>
<th>Coordinates</th>
<th>P arrival (min/sec)</th>
<th>S arrival (min/sec)</th>
<th>Difference (min/sec)</th>
<th>Distance from Epicenter (km)</th>
<th>Scale arc radius (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sunmer, MI</td>
<td>43.24 N/84.82 W</td>
<td>37:13</td>
<td>43:24</td>
<td>6:11</td>
<td>4800</td>
<td>112.7</td>
</tr>
<tr>
<td>Belgrade, NE</td>
<td>41.41 N/98.15 W</td>
<td>36:30</td>
<td>42:08</td>
<td>5:38</td>
<td>4100</td>
<td>96.2</td>
</tr>
<tr>
<td>Marconi Conference Center San Francisco, CA</td>
<td>38.14 N/122.88 W</td>
<td>35:20</td>
<td>40:06</td>
<td>4:46</td>
<td>3400</td>
<td>79.8</td>
</tr>
<tr>
<td>Seward Park, Seattle, WA</td>
<td>47.56 N/122.25 W</td>
<td>34:09</td>
<td>37:52</td>
<td>3:43</td>
<td>2600</td>
<td>61</td>
</tr>
</tbody>
</table>

For the map I provided the students, I also provided a scaling factor of 0.023475 mm/km that I determined from the known distances to the epicenter for each of the stations. These distances are provided on the website when you open the detailed seismograms from each station for the earthquake.

Multiplying the distances found based on arrival time differences, the students found those values listed for the distance to the epicenter for each station:

Using a compass, the students swung an arc at each distance from the station, in an attempt to match the point at which the arcs intersected to the location of the earthquake epicenter – which they knew going in was near Anchorage. Unfortunately – it was not a perfect match. Of the 4 stations, the one in San Francisco was the farthest off. This provided an opportunity to discuss how differences in rock structure between the earthquake and each station influences travel times. Also, a travel-time curve with a higher resolution may have helped get more accurate distances to the epicenter. I found the one I used at a SERC website: https://serc.carleton.edu/mathyouneed/graphing/interpret.html

Overall, the students could see how data from numerous locations are useful for analyzing seismic wave behavior and were much more open to learning more by the discussions this process fostered.
Outreach and Recruiting

Three hundred and fifty students attended the spring Fire Up Student Teacher’s Conference at Grand Valley State University on March 4th. This professional conference is held twice a year to provide student teachers an opportunity to engage in new learning techniques and practices, and connect with other teachers. Students could choose from over forty topics being offered during the 5 sessions scheduled throughout the day.

Steve Tchozeski and Rod Cranson attended to recruit new potential Michigan Earth Science Teachers Association members. Many students were contacted and 23 were enrolled under MESTA’s one-year free student membership policy. Steve was also a presenter and offered two hands-on sessions: Michigan Rock and Mineral Resources and How To Set Up a Mineral Dig In Your Classroom. Before introducing the activity, he provided a series of tips for how to get a teaching job - information students would not likely encounter anywhere else. In addition to instructions on how to conduct the activity, Steve provided a sample of the necessary earth materials. He also encouraged students to contact him for other mineral, rock or fossil material they may need for other classroom activities. In addition to his sessions, Steve sets up several tables of free and inexpensive classroom earth materials for students to purchase. The Inter-Institutional Teachers Education Council of West Michigan sponsored the Fire Up Student Teacher’s Conference - Steve and Rod have attended over the past two years to recruit student teachers for MESTA members.
Seismic Synopsis – Online Resources for Seismology

NGSS – Performance expectations that relate to seismology. More information about each of these can be found at: https://www.nextgenscience.org/search-standards

4-PS4-1 Waves and Their Applications in Technologies for Information Transfer
Develop a model of waves to describe patterns in terms of amplitude and wavelength and that waves can cause objects to move.

4-ESS3-2 Earth and Human Activity
Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans.

MS-PS4-1 Waves and Their Applications in Technologies for Information Transfer
Use mathematical representations to describe a simple model for waves that includes how the amplitude of a wave is related to the energy in a wave.

MS-ESS2-2 Earth’s Systems
Construct an explanation based on evidence for how geoscience processes have changed Earth’s surface over time.

MS-ESS2-3 Earth’s Systems
Analyze and interpret data on the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence of the past plate motions.

MS-ESS3-2 Earth’s Systems
Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects.

HS-PS4-1 Waves and Their Applications in Technologies for Information Transfer
Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.

HS-ESS1-5 Earth’s Place in the Universe
Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks.

HS-ESS2-3 Earth’s Systems
Develop a model based on evidence of Earth’s interior to describe the cycling of matter by thermal convection.

HS-ESS3-1 Earth and Human Activity
Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.

Activities/Lesson Plans and Other Resources
• The Teach Engineering website has a number of lessons built around NGSS for elementary, middle, and high school grades. Lessons relating to earthquakes and tectonics are found here: https://www.teachengineering.org/curriculum/browse?q=earthquakes

• Earthquakes and Volcanoes Around the World: This activity from the Concord Consortium has students use a computer model to explore the location of earthquakes and volcanoes and is designed for middle school. https://learn.concord.org/resources/915/earthquakes-and-volcanoes-around-the-world. More activities are available by using a simple choice matrix to select by practices and cross-cutting relationships.

• Determining Earth’s Internal Structure - https://bit.ly/2Fk3Akt. This lesson from IRIS (Incorporated Research Institutes for Seismology) allows students to use data to model the internal structure of our planet. Many more activities for your classroom can be found on their website: https://www.iris.edu/hq/educational_resources

• How to Build a Model Illustrating Seafloor Spreading and Subduction - https://pubs.usgs.gov/of/1999/ofr-99-0132/. This USGS publication is from a collection found at their Resources for Teachers page - https://on. doi.gov/2ucQnn7 and is intended for middle school students. Lesson for all grade levels can be found on the site.

• Latest Earthquakes: USGS Earthquake Hazard Program - https://earthquake.usgs.gov/earthquakes/map/. This page can be customized to show earthquakes of various magnitudes, and defaults to displaying the current dates earthquakes of magnitude 2.5 or higher in the U.S. You can also have it send you alerts.

• ShakeOut https://www.shakeout.org/schools/resources/ This site offers a collection of earthquake-related classroom activities across all grade levels.

• Earth Science Education Activities – Larry Braile, Purdue https://web.ics.purdue.edu/~braile/educindex/educindex.htm I had the opportunity to work with the author and other educators to review some of the activities found here. They are appropriate for middle and high school.

• SERC Site Guides – Earthquake Activities https://bit.ly/2W9JT4k. This site holds an extensive collection of activities and resources for teachers. Some may be too advanced for most high school students

• Also from SERC – Teaching About Hazards in Geoscience: Topical Resources. This site is a collection of resources you can use to help build seismology related lessons for your students. https://bit.ly/2UloezT
History of the Creation - Evolution Controversy

Part 1 – Rod Cranson

So what’s with the Creation - Evolution Controversy? Wasn’t that debate settled decades ago? That certainly is what the conventional scientific community would have you believe. However, there is another segment of our society/culture that apparently did not get the memo! Here are some interesting findings from a recent Gallup Poll (May 2017).

Thirty-eight percent of U.S. adults now accept creationism defined as God created humans in their present form within the last 10,000 years. Another thirty-eight percent believe that God was involved in man's creation whether according to the creationist view based on the Bible or that God guided the process through evolution. So, the bottom line is that three-quarters of Americans believe God was involved in the creation of humans! Of course, creationists include other areas of science beyond the origin of humans. Many aspects of geology, astronomy, and biology along with numerous other disciplines form the foundational concepts that are included in the various creation models.

Perhaps more obvious is what creationists have done over the last few years and continue to do. Here are a few recent examples. The Creation Museum, a major tourist attraction in northern Kentucky, was established in 2001. By mid-2015, 2.4 million people (about 300,000 visitors/year averaged over eight years) had visited the museum.

Another attraction a few miles south of Cincinnati along I-75, the Ark Encounter, reported ticket sales of over 860,000 between July 2017 and June 2018 - the first full season it was open. Both of these creation centered attractions were built and are operated by Answers in Genesis.

Another major creation museum is being constructed by the Institute of Creation Research (ICR) in Dallas, Texas. ICR’s Discovery Center for Science and Earth History is the culmination of decades of study and research. This state-of-the-art facility will feature exhibits that explore the key questions regarding origins and earth history. Visitors can experience a rich diversity of hands-on and interactive exhibits, including holograms and a 3-D planetarium. It is scheduled to open in 2019.

Still another way to understand how creationism has developed recently is to examine organizations that support various types of creation - there are many flavors. A simple search of the web produced a list of over a hundred creation organizations. These were scattered across some thirty states and does not include international creation groups in at least fifteen other countries. While the mainstream science community has largely ignored or dismissed creationists, it appears a segment of the population still supports some form of creation for how the earth, the universe and life came into being.

While the vast majority of conventional scientists supporting an evolutionary model for the origin of everything, the controversy with creation and creationists does not seem to go away. Perhaps a review of the history of creationism would be useful in understanding how we arrived at the present situation?

**Pre 1860s**

Traditionally, James Ussher’s (1581-1656) famous publication, Annals of the Old Testament (1650), was the generally accepted explanation for the creation of the world (earth). He represented the best of scholarship during his time and calculated the date of creation was about 6,000 years ago. By the late 1800s Ussher’s ideas were being disputed, especially the relatively young time frame claimed for creation.

Even so, prior to the beginning of the nineteenth century the creation account in Genesis of how everything came to be was widely accepted. In fact, many (most?) of the famous people responsible for the establishment of modern science were creationists. Included among these are Kepler, Galileo, Copernicus, Newton, Linnaeus plus a long list of others. Although creationism was the major philosophy at the dawn of the nineteenth century, it had serious competition.
There were several ideas about the earth’s formation prior to the 1800s. Followers of Plutonism, originally proposed by Anton Moro (1687–1750), believed volcanism played the major role in the formation of the earth’s features. Also, there was Neptunism, developed in the late 1700s, it challenged Plutonism and is credited to the German mining professor, Abraham Werner (1749–1817). He proposed that rocks formed from the crystallization of minerals in the early earth's oceans. There was considerable debate between the Neptunists and those favoring Plutonism.

Abraham Werner

Catastrophism was still another school of thought at the dawn of the nineteenth century. It held that the earth had been shaped by sudden, short-lived, violent events that occurred worldwide. In this concept major geological epochs had ended with violent natural catastrophes such as massive floods, mass extinctions and the rapid formation of mountains. The concept was first championed by French paleontologist, Georges Cuvier (1769–1832).

Georges Cuvier

At the time, Hutton’s book did not gain a wide audience as it was difficult to read. In time, however, that situation was remedied by John Playfair (1748-1819). He was a well known Scottish geologist and mathematician and reworked Hutton’s ideas, publishing them in 1802 as Illustrations of the Huttonian Theory of the Earth. Then, a few years later the drift away from creationism intensified significantly with the publication of the first geology textbook, Principles of Geology, authored by Charles Lyell (1794-1975). It was presented in three volumes between 1830-1833. Hutton’s uniformitarianism was popularized by Lyell’s textbook and subsequently he conducted field observations in Scotland, the United States, Canada, and France.

Charles Lyell

With publication of James Hutton’s Theory of the Earth in 1788, the tide started to turn away from creationism thinking in favor of his theory of uniformitarianism which explains the features of the earth's surface (crust) by means of natural processes over a long time frame. His field observations convinced him that the earth was much older than a few thousand years - he found “no vestige of a beginning – no prospect of an end.”