Atlanta Geological Society Newsletter

Next meeting of the Atlanta Geological Society is April 26, 2016
Fernbank Museum of Natural History (Clifton Road)
Social begins at 6:30 pm – Meeting begins at 7:00 pm

April 2016

ODDS AND ENDS
Dear AGS members,
As I mentioned in my email a couple of days ago, I believe that many of us need to pay our 2016 dues. I received a list of our paid members from Treasurer Lucy Mejai and it only had 23 names on it. And mine wasn’t one of them! We are not a rigid institution but we do need to keep up with our Society dues as that is the major source of the funds for the Society’s activities. I wonder if there is a cost effective way that we could do this electronically? I’ll check with my in-house IT staff (my wife and son) but maybe there is someone in the membership with some experience at this that could step up to fill this need. Looks like we need to find an easier way to pay our dues, to the AGS, that is. Even as strapped for free time as I am this month, I wanted to get the newsletter out this month. Besides a great speaker and generous sponsor (eyes right, please), there are a couple of interesting articles how tectonics apparently changes the climate. One might implicitly understand this but to see the science that suggests/proves it is great and eye-opening. It is as if we are building a great pyramid of geologic and earth science knowledge. We think we are done but then someone finds a new stash building blocks that need to added to the pyramid to make it even higher.
Ben Bentkowski, 
Newsletter Editor

April Meeting
Join us Tuesday, April 26, 2016 at the Fernbank Museum of Natural History, 760 Clifton Road NE, Atlanta GA. The meeting social starts at 6:30 pm and the lecture starts shortly after 7 p.m.

This month the speaker will be Randall W. Carlson. His presentation will be Terminal Ice Age Megafloods: Exploring the Landscapes of Catastrophe. The Speaker’s biography and the abstract for the presentation are presented on the following pages.

Our generous, returning sponsor for the evening is A.E. Drilling. Their information is on Page 4

Please come out, enjoy a bite to eat, the camaraderie, and an interesting talk. As a reminder, next Saturday is the P.G. Study group where Ginny Mauldin will discuss geomorphology. See Pg. 8 for info.
Terminal Ice Age Megafloods: Exploring the Landscapes of Catastrophe

Abstract: Since the early 1920s and the work of J Harlen Bretz, evidence has been growing that the termination of the Wisconsin Ice Age was extremely rapid and involved meltwater floods of extraordinary magnitude. The most well-known of these are the so-called Missoula Floods that swept over the Pacific Northwest contemporaneous with the Bølling-Allerød/Younger Dryas climate transitions, in the process producing the anastomosing plexus of erosional forms in SE Washington State known as the Channeled Scablands. However, major flood events occurred in numerous other locations around North America as well. The Bonneville Flood resulting from the catastrophic overflow of Lake Bonneville, of which Great Salt Lake, Utah, is a remnant, is also fairly well known. Many massive “superlakes” formed and drained catastrophically during the period of glacial retreat. All major North American rivers that rise in formerly glaciated regions are underfit streams, occupying outsized valleys formed by enormously augmented meltwater flows. A variety of geomorphic forms such as coulees, tunnel valleys, debris fans, boulder fields, drumlin swarms, over-deepened lake basins, and macro-scale bedforms may be attributed to terminal Pleistocene megafloods.

The exact relationship and timing of these events has yet to be established with precision and a number of controversies have arisen in recent decades as to the number of floods, their causes and geographic distribution. In regards to the Missoula Floods the prevailing causal theory holds that a large proglacial lake broke through its impounding glacial dam in northern Idaho, producing a massive jökulhlaups, or outburst flood, with discharges possibly exceeding 20 million m³/sec. Studies of slackwater depositional facies have resulted in the assumption that this process took place dozens of times, perhaps as many as 80 or 90 times. There are certain problems inherent in this model, both theoretical and empirical. Evidence supports the conclusion that the Missoula Floods were part of a much more extensive phenomenon of accelerated glacial melting over the whole Cordilleran-Laurentide ice complex. Depositional hiatuses suggest the melting occurred in several discrete pulses separated by longer periods of decelerated melting. Questions regarding the energy requirements for the tempo of glacial retreat have not been satisfactorily addressed.

The general timing of these megafloods suggest a correlation with oceanic meltwater pulses, the interruption of the North Atlantic thermo-haline convection current, the extreme Bølling-Allerød/Younger Dryas/Preboreal climate oscillations, rapid meltdown of the Fennoscandian ice sheet, disappearance/disruption of the North American Clovis culture and the terminal Pleistocene megafaunal extinctions. The question of ultimate cause, or causes, of these dramatic global change events remains open.
Randall W. Carlson Bio:

Randall Carlson is a professional builder and co-owner of Archetype Design/Build Inc. He is a native of rural Minnesota where he developed a love for geology early in life. He majored in geology at Dekalb College where he was awarded outstanding geology student of the year for 1993. He has continued his interest in geology as an avocation with a primary interest in discontinuities and catastrophes in the geological record. Over the past two and a half decades he has logged approximately 40-thousand road miles of travel over North America to hundreds of sites, studying the effects of the Late Wisconsin Ice Age and its rapid termination ca 11 to 14 thousand years B.P. along with other phenomenon associated with extreme events such as impact craters, volcanic eruptions and Late Pleistocene megafaunal death assemblages. His focus has been directed primarily at the evidence for catastrophic megafloods associated with the recession of the vast Laurentide/Cordilleran ice complex, and is currently working on a book to detail these studies.
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Ancient tectonic activity was trigger for ice ages, study says

April 19, 2016 by Jennifer Chu


For hundreds of millions of years, Earth’s climate has remained on a fairly even keel, with some dramatic exceptions: Around 80 million years ago, the planet’s temperature plummeted, along with carbon dioxide levels in the atmosphere. The Earth eventually recovered, only to swing back into the present-day ice age 50 million years ago.

Now geologists at MIT have identified the likely cause of both ice ages, as well as a natural mechanism for carbon sequestration. Just prior to both periods, massive tectonic collisions took place near the Earth’s equator—a tropical zone where rocks undergo heavy weathering due to frequent rain and other environmental conditions. This weathering involves chemical reactions that absorb a large amount of carbon dioxide from the atmosphere. The dramatic drawdown of carbon dioxide cooled the atmosphere, the new study suggests, and set the planet up for two ice ages, 80 M and 50 M years ago.

"Everybody agrees that on geological timescales over hundreds of millions of years, tectonics control the climate, but we didn't know how to connect this," says Oliver Jagoutz, associate professor of Earth, Atmospheric and Planetary Sciences (EAPS) at MIT. "I think we're the first ones to really link large-scale tectonic events to climate change."

A weathering trigger - For this new paper, the researchers wondered whether the tectonic collisions in this extremely tropical region may have played a part in pulling huge amounts of carbon dioxide out of the atmosphere and triggering the ice ages. Certain types of rock, if exposed to high heat and heavy rain, undergo chemical reactions and effectively absorb carbon dioxide, a process known as silicate weathering. These rocks include basalts and "ultramafic" rocks, which are often found within oceanic plates. If these rocks are exposed to the atmosphere in a tropical region, they can act as very efficient carbon sinks.

The team hypothesized that the two collisions, involving Africa and then India, brought basaltic and ultramafic rocks up from the oceans and onto land, creating carbon sinks 80 and 50 million years ago. Both collisions also effectively turned off carbon sources by burying volcanoes that had been emitting carbon dioxide and other gases into the atmosphere.

Ancient tectonic activity was trigger for ice ages (cont)

To know whether such a sequence of events directly reduced carbon dioxide in the atmosphere, the researchers looked to weathering rates of different rock types, including granites, basalts, and ultramafics. These rates, which have been calculated by other researchers, describe the way rocks erode and take up carbon dioxide, given exposure to a certain amount of rainfall.

They then applied these weathering rates to their model’s estimates of the amount of oceanic plate that was pushed up onto Africa and India, at 80 and 50 million years ago, respectively. After determining the amount of carbon dioxide sequestered by these rocks, they calculated the total amount of atmospheric carbon dioxide through time, from 100 million years ago to around 40 million years ago.

The team found that carbon dioxide dipped dramatically at precisely the time the two collisions occurred. The levels of carbon dioxide also mirrored the temperature of the oceans during this interval.

Jagoutz says one reason these two collisions had such an extreme effect on atmospheric carbon dioxide may have been the fact that each continent continued moving north, exposing new basaltic and ultramafic material, "like a bulldozer that brings fresh rock to the surface."

Interestingly, a similar process is taking place today, albeit at a smaller scale, near the island of Java. The same tectonic activity that shifted Gondwana northward more than 100 million years ago is today pushing the Australian plate north, and as a result, is piling up basaltic material on Java within the ITCZ, which Jagoutz says is "a huge carbon sink."

"What nature shows us is, if you put a lot of these rocks in the tropics, where it’s hot, muggy, wet, and rains every day, and you also have the effect of removing the soil constantly by tectonics and thus exposing fresh rocks, then you have an excellent trigger for ice ages," Jagoutz says. "But the question is whether that is a mechanism that works on the timescale that is relevant for us."

"To confidently estimate the long-term fate of fossil fuel carbon in the atmosphere, we need to fully understand the dynamics of the carbon cycle and how it operates on all time scales," says Lee Kemp, professor of geosciences at Penn State University. "This study highlights an important restorative force of the carbon cycle. The 'repair mechanism' for volcanism-induced warming is the chemical weathering of the volcanic rocks themselves—a repair job that takes millions of years."
The more technical version:

**Low-latitude arc–continent collision as a driver for global cooling**

**Authors**: Oliver Jagoutz\(^a\), Francis A. Macdonald\(^b\), and Leigh Royden\(^a\)

**Significance**

This manuscript provides a mechanism for triggering cooling events following the Cretaceous Thermal Maximum and the Early Eocene Climate optimum that ultimately resulted in the Cenozoic glaciation. We present a quantitative model of changes in CO\(_2\) sources and sinks during the closure of the Neo-Tethys Ocean. Our results suggest that long-term cooling was predominantly due to obduction of highly weatherable mafic and ultramafic Ca- and Mg-rich rocks (ophiolites) in the wet tropics. Our model accounts for both the two episodes of cooling and also the partial recovery in temperatures between \(\sim 70\) and 50 Ma.

**Abstract**

New constraints on the tectonic evolution of the Neo-Tethys Ocean indicate that at \(\sim 90–70\) Ma and at \(\sim 50–40\) Ma, vast quantities of mafic and ultramafic rocks were emplaced at low latitude onto continental crust within the tropical humid belt. These emplacement events correspond temporally with, and are potential agents for, the global climatic cooling events that terminated the Cretaceous Thermal Maximum and the Early Eocene Climatic Optimum. We model the temporal effects of CO\(_2\) drawdown from the atmosphere due to chemical weathering of these obducted ophiolites, and of CO\(_2\) addition to the atmosphere from arc volcanism in the Neo-Tethys, between 100 and 40 Ma. Modeled variations in net CO\(_2\)-drawdown rates are in excellent agreement with contemporaneous variation of ocean bottom water temperatures over this time interval, indicating that ophiolite emplacement may have played a major role in changing global climate. We demonstrate that both the lithology of the obducted rocks (mafic/ultramafic) and a tropical humid climate with high precipitation rate are needed to produce significant consumption of CO\(_2\). Based on these results, we suggest that the low-latitude closure of ocean basins along east–west trending plate boundaries may also have initiated other long-term global cooling events, such as Middle to Late Ordovician cooling and glaciation associated with the closure of the Iapetus Ocean.

http://m.pnas.org/content/early/2016/04/13/1523667113

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1. Edited by Peter B. Kelemen, Lamont-Doherty Earth Observatory, Palisades, NY, and approved March 2, 2016 (received for review December 1, 2015)
Announcement for the next
Atlanta Geological Society PG Candidate Workshop:

Date: Saturday, April 30, 2016
Time: 10:00 am to 12:00 pm
Venue: Fernbank Science Center Annex
156 Heaton Park Drive,
N.E. Atlanta, GA 30307   678-874-7102  http://fsc.fernbank.edu/  Map to Fernbank

Speaker: Ginny Mauldin-Kinney
Subject: Geomorphology

Ginny will lead a class on several topics of geomorphology including: karst topography, eolian, volcanic and crustal plate boundary landforms. She will also touch on stream, shoreline, landslide and fault geomorphology. She will emphasize the environments in which these features formed, and their history.

Ginny works in the Engineering Design division of AGL Resources designing natural gas delivery systems. She has earned a M.S in Geology from Georgia State University with research emphasizing the geomorphology on the planet Mars. She also serves as a Solar System Ambassador with NASA’s Jet Propulsion Laboratory.

Check with the receptionist as you come in Fernbank Science Center for directions to the classroom we will be using. The Center is approximately 1-mile north off East Ponce deLeon Avenue from the Fernbank Museum Of Natural History where the AGS monthly meetings are held. Also, please forward this message to anyone interested in becoming a Georgia Registered Professional Geologist, or anyone who might be interested in the topic. The classes are open to all. Membership in the AGS is not required, however, $25 per year ($10 for students) is quite a bargain for one the most active geological groups in the Southeast.

If you have any questions, go to the AGS web site at http://www.atlantageologicalsociety.org or contact us below. We hope to see you there!

Ken Simonton, P.G.  Ginny Mauldin-Kinney
kws876@gmail.com  ginny.mauldin@gmail.com
Atlanta Geological Society
Professional Registration Committee
Chemical weathering controls erosion rates in rivers


A bedrock-floored streambed after a recent flow event in Kohala Peninsula. Credit: Brendan Murphy

Chemical weathering can control how susceptible bedrock in river beds is to erosion, according to new research. In addition to explaining how climate can influence landscape erosion rates, the results also may improve scientists' ability to interpret and predict feedbacks between erosion, plate tectonics and Earth's climate.

The research, led by The University of Texas at Austin, was published in *Nature* on April 14, 2016.

"Our research presents a specific, process-based mechanism to explain how and why river erosion depends on climate, and also perhaps why previous studies have found conflicting sensitivities to climate in different landscapes," said Brendan Murphy, a Ph.D. student at The University of Texas Jackson School of Geosciences who led the research.

Murphy conducted the research with Joel Johnson, a professor in the Jackson School's Department of Geological Sciences, Nicole Gasparini of Tulane University and Leonard Sklar of San Francisco State University.

Chemical weathering occurs when minerals in rock react with water. These chemical reactions physically weaken rock by altering its structure. Rocks in streambeds then become more susceptible to erosion by physical processes, such as impacts by sediment carried in flowing water.
Chemical weathering controls erosion rates in rivers (cont)

It has been established that chemical weathering influences rock strength, Murphy said. But scientists have lacked data on the extent to which chemical weathering influences river erosion. To explore the issue, the team travelled to the Big Island of Hawaii, where the bedrock is made entirely of volcanic basalt, to collect data on chemical weathering, rock strength, and erosion rates in streams across wet and dry regions of the island. "Hawaii is a simple, natural laboratory for studying how climate controls river erosion because it has uniform lithology and a very extreme precipitation gradient," Murphy said. "We went to investigate if the local precipitation rate was changing the rock strength in the rivers and then looked for a mechanism to explain it."

They measured the strength of the rock using a Schmidt hammer, a device that measures surface hardness in the field, and also analyzed the chemistry and density of rock samples back in the lab to determine the influence of chemical weathering. Consistent with their hypothesis, they found that bedrock was more chemically weathered and physically weaker where local precipitation rates were greater. More significant, Murphy said, was their finding that locations of high precipitation rates could maintain high erosion rates despite continuously exposing "fresh rock" - rock that was previously below the eroded surface and is not chemically altered. Fresh bedrock weathers rapidly when exposed at the surface, which weakens rock and allows it to be efficiently eroded by the river, the researchers found. "This presents a positive feedback allowing river streambeds to maintain high weathering rates, weaker rock, and high erosion rates," Murphy said.

Based on their findings, the researchers modified a numerical model that describes how rivers cut into a landscape, Johnson said, finding that chemical weathering data drastically improved their ability to predict patterns of river incision. "Once we included the climate effect demonstrating that the chemical weathering is weakening the bedrock and making it more erodible, we can do a much better job of matching the pattern and rates of incision that occur across this landscape." Johnson said.

Even though researchers examined only a single rock type, Murphy said that the mechanism linking chemical weathering to rock strength and erosion should apply to all types of rock. Understanding the relationship between erosion and chemical weathering can help tease out the role climate has on sculpting landscapes and influencing global cycles, Murphy said. "The ability to better understand how landscapes erode is important, because bedrock erosion affects chemical weathering, which is a major component of the global carbon cycle and can influence global climate by the removal of carbon dioxide from the atmosphere," Murphy said. "The ability to model landscape evolution and how climate plays into it is important for tying these larger global cycles together."

Explore further: New insights: How soil production processes respond to erosion


Journal reference: Nature Provided by: University of Texas at Austin
Rivers through time, as seen in Landsat images


Thanks to the Landsat program and Google Earth Engine, it is possible now to explore how the surface of the Earth has been changing through the last thirty years or so. Besides the obvious issues of interest, like changes in vegetation, the spread of cities, and the melting of glaciers, it is also possible to look at how rivers change their courses through time. You have probably already seen the images of the migrating Ucayali River in Peru, for example here. This river is changing its course with an impressive speed; many – probably most – other rivers don’t show much obvious change during the same 30-year period. What determines the meander migration rate of rivers is an interesting question in fluvial geomorphology.

The data that underlies Google Earth Engine is not accessible to everybody, but the Landsat data is available to anyone who creates a free account with Earth Explorer. It is not that difficult (but fairly time consuming) to download a set of images and create animations like this: Please click the link above to get the animation to work. Ed.

This scene also comes from the Ucayali River (you can view it in Google Earth Engine over here) and it is a nice example of how both neck cutoffs and chute cutoffs form. First a neck cutoff takes place that affects the tight bend in the right side of the image; this is followed by a chute cutoff immediately downstream of the neck cutoff location, as the new course of the river happens to align well with a pre-existing chute channel. The third bend in the upper left corner shows some well-developed counter-point-bar deposits. There is one frame in the movie for each year from 1985 to 2013, with a few years missing (due to low quality of the data).

Update (04/14/2016): If you want to use the animation, feel free to do so, as long as you (1) give credit to NASA/USGS Landsat, (2) give credit to me (= Zoltan Sylvester, geologist), and (3) link to this page. Note that you can see/download the high-resolution version if you click on the image. The links are a bit wonky but worth the effort to follow to see the snake-like action. Ed.
Earth’s Magnetic Field May Not Have Existed Without The Moon
April 1, 2016 | by Robin Andrews

Earth’s magnetic field is our greatest vanguard: It protects us against dangerous incoming solar radiation that, left unchecked, would make the existence of life on our world all but impossible.

And now a new study in the journal Earth and Planetary Science Letters has suggested something truly remarkable: our world’s magnetic field could not be sustained without the help of the Moon. This has enormous implications for how scientists not only view planetary formation, but how they may look for life elsewhere in the cosmos.

“In this scenario... the habitability on Earth appears to require the existence of a large satellite,” wrote the team of researchers, led by Denis Andrault from the Université Blaise Pascal.

The physics of Earth’s magnetic field is not entirely understood, but it’s almost certainly generated within the outer core layer of the planet, which contains broiling, liquid metallic iron and nickel. The heat escaping from the depths up to the surface sets up cycling convection currents within the outer core, and this movement of magnetic materials generates a powerful magnetic field that extends far beyond the surface of the planet.

When charged particles from the Sun travel towards us – a phenomenon known as “solar wind” – our magnetic field deflects these particles, preventing them from stealing away our atmosphere. Without an atmosphere, these particles would bombard Earth’s surface, making life far less likely to exist, if not impossible.

As this study reveals, however, there’s a catch. In order for there to be convection in the outer core, there needs to be a large temperature difference from the inner core to outer core, and the outer core to the mantle, the semi-molten layer that makes up around 84 percent of Earth’s volume. If there is no major temperature difference, there will not be efficient convection, and there will be no magnetic field.

The new model: Over time, the convection switches from being thermally driven to being driven by the Moon’s tidal forces. Andrault et al./EPSL
Earth's Magnetic Field May Not Have Existed Without The Moon (cont.)

Conventional models state that the Earth’s core needs to have very slowly cooled from 6,800°C (12,272°F) to 3,800°C (6,872°F) for there to be efficient convection. After carefully sifting through experimental studies, mathematical models, and long-touted arguments about the current condition of Earth’s innards, the authors conclude that Earth’s depths have only cooled by around 300°C (572°F) since its fiery birth 4.54 billion years ago. This implies that Earth’s magnetic field isn’t being generated by conventional convection.

So where is it coming from? Well, as it turns out, our Moon may be our silent guardian. Although it’s weak, its gravitational pull on Earth may be responsible for not only generating tides at the surface, but also deep within the outer core by mechanically “stirring” its liquid contents. This tidal mechanism has already been observed causing powerful volcanism on Jupiter’s Io and Saturn’s Enceladus. On Earth, the pull of the Moon is far less powerful, but still manages to generate around a trillion watts of power within the outer core.

This would be enough to mechanically force efficient convection in the outer core, meaning that our Moon – working with the metallic, liquid core – may be responsible for sustaining our magnetic field, without which we would not exist. “We found out that this possible effect of the Moon had already been proposed about 50 years ago,” Andrault told IFLScience. “However, no one since then had argued that this effect could be important.”

The enigmatic lack of a magnetic field on Mars may be one of the reasons that complex life failed to evolve on the Red Planet. Perhaps, as the study suggests, it didn’t have the right kind of moon watching over it.

http://www.iflscience.com/space/earths-magnetic-field-would-not-exist-without-deep-tides-created-moon

For your consideration. Not geology but the price is right. Ed.


Ten Awesome Science Courses You Can Take Online For FREE

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**Wild Music**  On view February 6 – July 31, 2016
Whales compose, bullfrogs chorus, songbirds greet the dawn, and people everywhere sing and dance. What do we all have in common? Music is all around us. Explore sound and music in nature and in life through whimsical, hands-on activities.
[Learn more](#)

**Humans in Space Youth Art Competition**  Now on View
See an inspiring selection of winning entries from the international Humans in Space Youth Art Competition. Youth ages 10-18 were asked to visually communicate their vision of the future of space science, travel and exploration. The competition is part of the Humans in Space Art Program and received more than 2,000 entries from 52 countries. Fernbank’s display will feature 30 of the winning entries. This temporary exhibition located in *The Star Gallery*, Lower Level.
[Learn More](#)

**Creatures of Light: Nature’s Bioluminescence**
On view March 26 – August 14, 2016
Explore the extraordinary organisms that produce light, from the flickering fireflies found in backyards around the world to the alien-like deep-sea fishes and other fantastic creatures that illuminate the perpetually dark depths of the oceans. Learn how, where, and why scientists study this amazing natural phenomenon.
[Learn more](#)
Now Showing in the Fernbank IMAX movie theater:

**Wild Africa**  Showing through May 12, 2016
Travel from enchanted forests to the boiling edge of the underworld, from celestial ice-capped mountains and lava-spewing volcanoes, to crashing waterfalls and deep fantastical seas. And experience some of the greatest gatherings of wildlife ever captured on film. [Learn more](#)

**National Parks Adventure**  Showing through June 16, 2016
Experience the ultimate off-trail adventure into the nation's awe-inspiring great outdoors and untamed wilderness. Follow modern-day explorers as they explore spectacularly wild and beautiful places, including Yellowstone, the Everglades and the Redwoods. This new film will inspire the adventurer in all of us while celebrating the majesty of our national parks. [Learn more](#)

**Coming Soon**  A Beautiful Planet  Opens May 13, 2016
See an awe-inspiring glimpse of Earth from space, providing a unique perspective and increased understanding of our planet and galaxy as never seen before. Made in cooperation with the National Aeronautics and Space Administration (NASA), this film features stunning footage of our magnificent blue planet, captured by the astronauts aboard the International Space Station (ISS).
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AGS 2016 Meeting Dates
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2016 Meeting Schedule
The last Tuesday of the month
April 26
Randall W. Carlson
Terminal Ice Age Megafloods: Exploring the Landscapes of Catastrophe.
May 31 June 28
August 30 September 27
October 25 November 29

PG Study Group meetings
last Saturday of the month.
April 30
Speaker: Ginny Mauldin-Kinney
Subject: Geomorphology
May 28
June 25

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For further details, contact the AGS Treasurer: Lucy Mejia: telephone: 404-438-9584; Lucytaylor360@gmail.com

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