CelloStone,
Unconventional Thought
Exceptional Playability

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The CelloStone removes vibrations from the string that are responsible for the "wolf note" while not interfering with the vibrations the cello uses to make music. The CelloStone is the result of a new understanding of how the violin family translates bowings into music.

There are two polarizations of vibrations created by bowing the cello. One is the voice of the cello, the other interferes with bowing and creates a "wolf note". The CelloStone removes the interfering polarization of the vibration on the strings of the cello; making the bowing smoother and easier, so it is easier to learn the various bowings of the cello. Removing the interfering vibrations also brings a clearer voice to the cello. The CelloStone makes it easier to teach the cello while bringing out the best voice of the cello. In addition, this understanding of how the cello makes music yields a better understanding of how the endpin works and how to optimize its role.

Learn more by clicking the links below:

Video Demonstration of the CelloStone

Hannah Alkire, cellist, of Acoustic Eidolon demonstrates the CelloStone. This clip was recorded live during a Woodsong"s TV show on PBS about Acoustic Eidolon. It is a 1:31 minute snippet from the program:

https://www.youtube.com/watch?v=NOZ1rrQtPQc

What is the Wolf Note?

The “wolf note” is a tone that when played on a cello, creates a beating sound. It has always been thought that the “wolf note” had a single cause, since it is generally in a fairly narrow pitch range (E to G) and was thought to be a coupled oscillation, a second peak excited in the body of the cello. We found that a trough added to a single fundamental peak was the cause of the double peak, figure 2 and when the endpin was placed on the CelloStone that the trough was removed. None of the fundamental frequency nor the harmonics were affected. We found when the endpin was on a concrete floor or on a CelloStone, there could still be a “wolf note” on the D string which has a different amplitude-frequency graph. Thus there had to be a second cause of the “wolf note”. It was determined that the soundpost was the cause of the second “wolf note”. We use the term “string wolf note” to denote the “wolf note” caused by the interfering vibrations on the strings and the term “soundpost wolf note” for the “wolf note” caused by the harmonics being off.

When the polarity of vibrations causing the string “wolf note” was removed; the soundpost “wolf note” on the D string was still there. It was found that both the interfering vibration and/or an improperly adjusted sound post could create the beating sounds of the “wolf note”. The two sources of “wolf notes” may interact with each other causing the “wolf note” to change pitch with different temperatures and humidity’s. The string “wolf note” does not change with humidity or temperature, allowing the CelloStone to remove it. However the soundpost “wolf note” will change with humidity and temperature even when a CelloStone is used. The sound post “wolf note” is generally found on the D string near an F. The string “wolf note” is generally found on the G string near an F.

Figure 1 shows the amplitude spectrum of the string “wolf note”. The double peak, on the fundamental frequency of the note, (left most peak at about 174 hz) causes the beating sound of the “wolf note”. Originally physicists thought that the second peak was a coupled oscillation, a second frequency peak that was excited when the string vibrated at that specific frequency. In reality, the CelloStone shows that the cause, of the string “wolf note“, is a trough at the same frequency as the fundamental which adds to the fundamental causing the appearance of a double peak. The “wolf note” is the double peak (red) at the fundamental frequency of about 174 hz on figure 1.

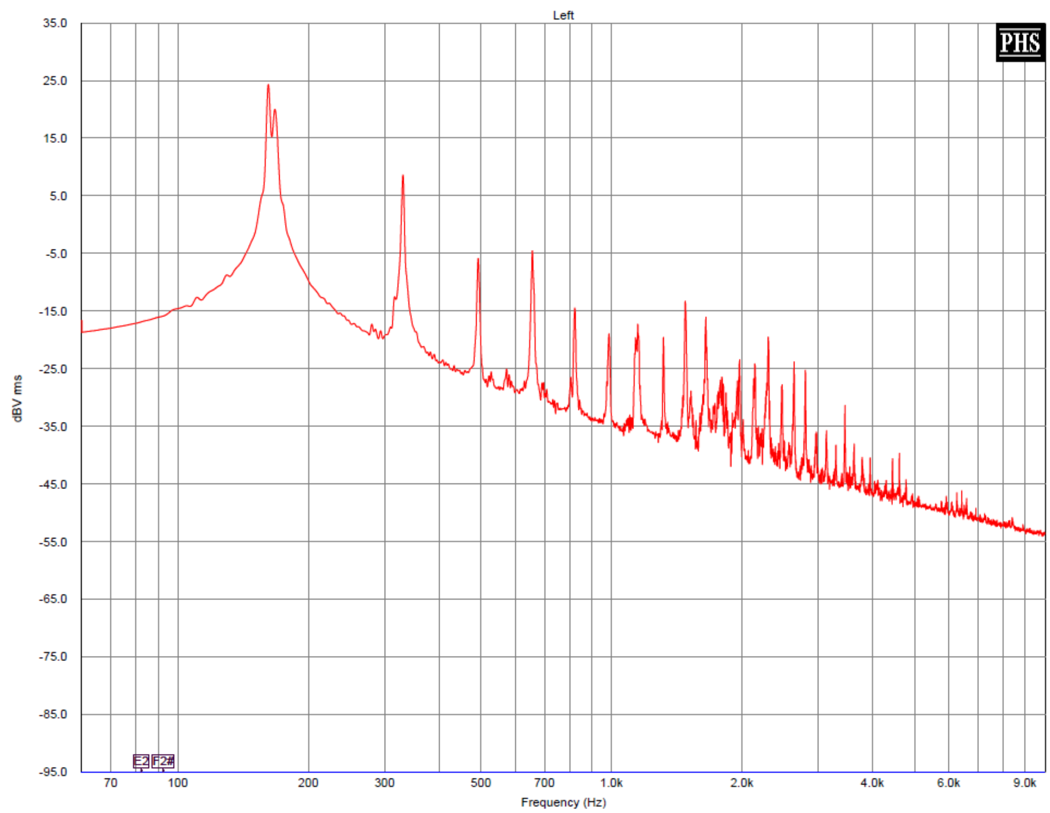

Figure 1 The red line is the Amplitude –Frequency spectrum of a "wolf note". The fundamental frequency (left most peak) has a double peak which creates a beating sound. The other peaks are at frequencies that are exact multiples of the fundamental.

When the trough (interfering vibration) is removed by the CelloStone, a single peak is all that remains, figure 2 (purple). Note that none of the fundamental frequency nor any of the harmonic frequencies are removed by the CelloStone. All of the frequencies show additional power in those peaks.

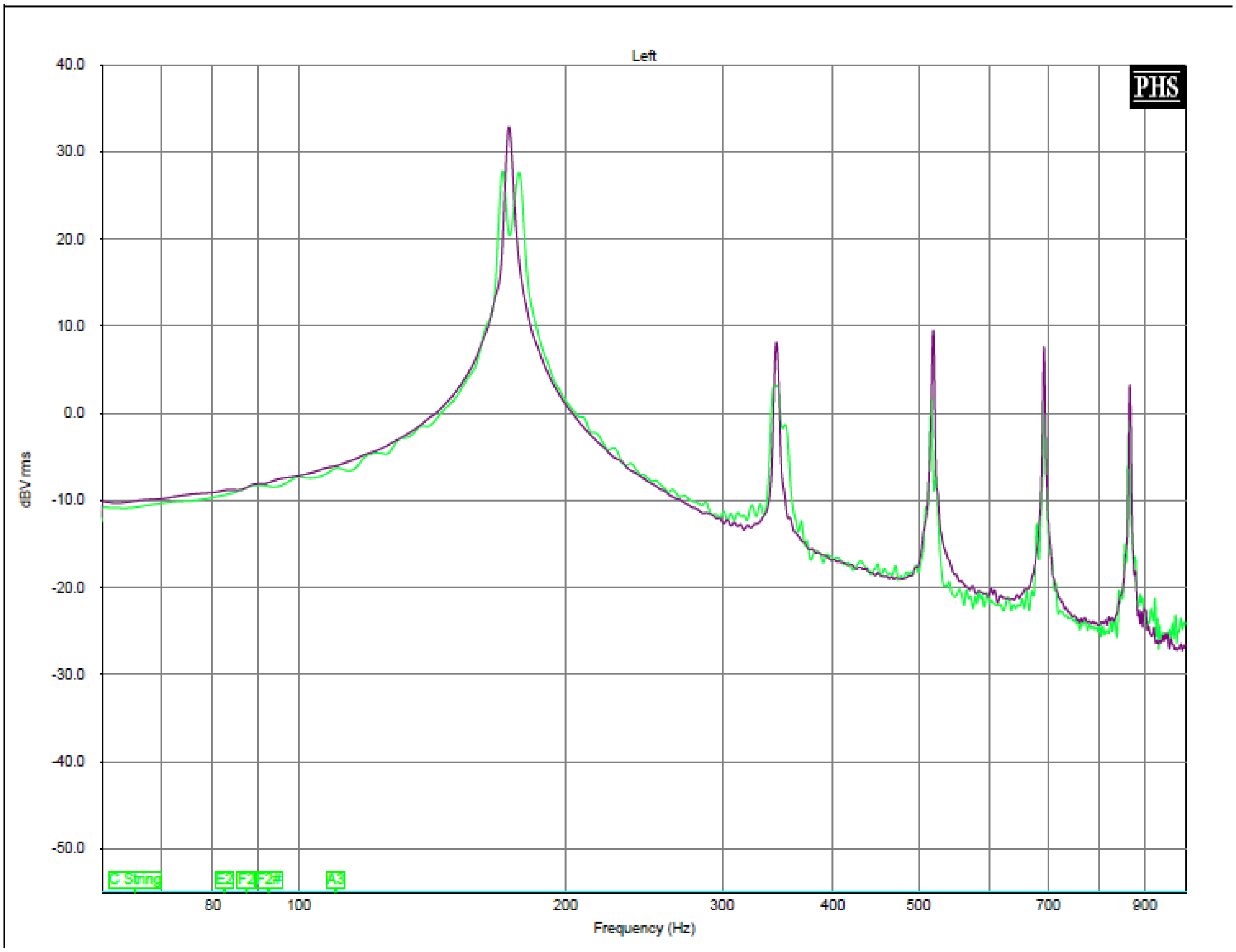

Figure 2 Amplitude- Frequency graph of a cello playing the "wolf note", green, and then the same note on the same cello with the endpin on a CelloStone, purple.

A musical note is a combination of the fundamental frequency (what we hear as the specific pitch) and the harmonics (multiples of the fundamental frequency). In figure 1 there is a fundamental at about 174 hz and harmonics at about 348 hz, 518hz, 692 hz, 870 hz. The harmonics give the color and depth to the sound. A high quality cello will produce harmonics above 10,000 hz.

When the soundpost was not adjusted correctly, or is out of adjustment, instead of a double peak at the fundamental, the harmonics are not exact multiples of the fundamental. This causes a beating between the fundamental and the harmonics. This is not interfering vibration in the cello but a mismatch of the vibrations in the front and the back plates of the cello.

CelloStones have a measurable affect

Figure 2 is a Frequency-Amplitude graph from a recording using a microphone placed about 3 feet (just under a meter) in front of the cello. The graph shows that the spectrum of the wolf note, with the endpin of the cello on a carpet, is a double peak (green). The other spectrum, purple, is the exact same note (same finger position) but with the endpin on a CelloStone. (Just as in the video). The CelloStone is based on principles similar to putting on polarizing glasses to remove the glare, while still seeing everything else clearly.

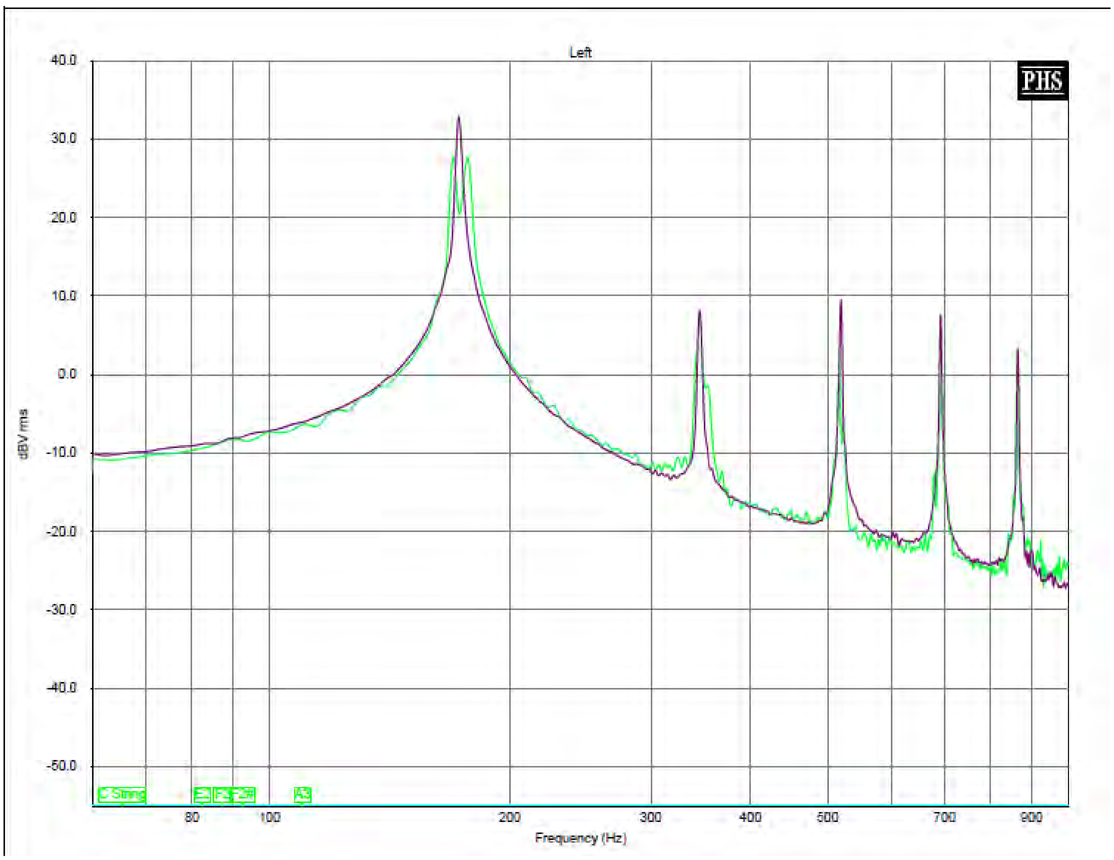

Figure 2 Amplitude- Frequency graph of a cello playing the "wolf note", green, and then the same note on the same cello with the endpin on a CelloStone, purple

The fundamental frequency, the note being played, has a double peak when the endpin is on the carpet because the trough at that frequency is not attenuated by the carpet (green). When a trough is added to a single peak at the same frequency the result is the double peak. The trough exists when the endpin is on carpet and is removed when the endpin on a CelloStone, purple. The double peak is the spectral representation of the characteristic “beating” sound of the note and of the physical stuttering of the bow.

The spectrums from recordings of the wolf on a wood, tile or carpeted floor, all have the characteristic double peak. Only the CelloStone or a concrete floor remove the differently polarized vibration.

The interfering vibration can also be felt in the bow's response, as it causes a vibration on the surface of the string that interferes with bowing. Without the vibration on the string, the bow moves easier and smoother, as well as initiating quicker. This same vibration can be felt in the handle of a tuning fork and is removed when the tuning fork is placed on a CelloStone.

String family instruments all suffer from the interfering vibration, though it is manifested differently in the different instruments. In the violin, it is a generally a peak added to the note causing the "wolf note" to be louder than it should be.

Since the CelloStone is removing a specific polarization of vibration, the cello's string "wolf note" will not return with changes in humidity and temperature. Minor "wolf notes" will show up as the soundpost adjusts to the variations in the cello.

The CelloStone is like polarizing sunglasses for the cello's voice- it just removes the glare from the voice of the cello.

Endpin length effects cello voice

The cello and endpin need to vibrate in harmony with each other. The endpin is a tool the cello uses to allow the interfering vibrations created in the strings, to travel into the floor, carpet, wood floor, concrete floor, or rockstop, though not all the surfaces the endpin comes in contact with will dissipate the interfering vibrations. If the endpin of the cello is clamped at the resonance point, the interfering vibrations are able to freely travel to the floor and can be dissipated some, changing the response of the cello.   If the endpin is clamped above the resonant point on the endpin, some of the interfering vibrations can still travel to the floor but not a majority of them. If the endpin is clamped below the resonant point nearly all the vibrations will stay in the cello giving the cello a more muted sound. It is important to clamp the endpin at the resonant point so that the cello can perform at its best for a given floor. To remove the polarization of vibrations that interfere with the cello, the endpin needs to be, clamped at the resonant point and sitting on a concrete floor or CelloStone.

The resonant point of the endpin is always at the same place proportionately. In other words, the length of the endpin may be sized, so that when clamped at the resonant point, the length is also correct for the cellist. The resonant point of the endpin is around 1/3 the distance from the top of the endpin.

Most cellists prefer a more open voice of the cello and so choose endpins which allow vibrations to move through them. By clamping the endpin at the resonant point, the cello will produce the best sound, in that situation.

When comparing cellos, buying a new cello, or just trying out a cello, the endpin should be clamped at the resonant point giving all the cellos being tried the same amount of energy traveling into the floor. Placing the endpin on a concrete floor, when it is clamped at the resonant point, brings out more of the optimum voice of the cello.

Finding the Endpin's Resonant Point

To find the resonant point of the endpin, pull the endpin out of the cello body and hold it vertically between your thumb and index finger, with the pointed end toward the ground, and grasping it at a point about 1/3 from the top. Tap the lower part of the endpin with a finger or pen to make a ringing sound. If the tap produces a buzzing or dead sound, move where you are holding the endpin a little up and tap a few other places and then down the endpin, tapping until you find the maximum ringing sound or vibration.

There will be areas where the endpin sounds and feels dead and areas where it resonates, and one point it will resonate best (both in feel and tone). Mark the point on the endpin that resonates best with a felt tip marker or similar. Clamp the endpin at this point and play. Do you like this sound and are the strings easier to bow? Then shorten the endpin (put more endpin into the body of the cello) and play. What do you think of this sound and feel?

Sizing the endpin to the Cellist

Nearly all endpins have a resonant or nodal point. The location of the resonant point is always at the same proportionate length for a specific endpin. The resonant point of the endpin is the point that, when held between two fingers, allows the endpin to ring or vibrate. Pull the endpin from the cello body and hold it vertically between your thumb and index finger at about 1/3 of the length from the top, pointed end toward the ground. Tap the endpin close to the end toward the floor with a finger nail or pen to make a ringing sound. If the tap produces a buzzing or dead sound, then move your grasp toward the top and/or bottom of the endpin tapping until you find the maximum ringing sound. Depending on the material of the endpin, the resonant point will usually be between the upper 1/3 and ¼ of the length of the endpin.

To calculate the length of the endpin to fit a particular cellist:

Pull the endpin out of the cello and measure the total length of the endpin; this is length (a). Measure the length of the end pin from the cellist's preferred clamp point to the tip of the endpin (the end that goes on the floor); this is length (b). Finally you will need to determine the resonant point. The resonance point is the point, when held between your fingers, allows the endpin to noticeably ring when tapped. Measure from the resonance point to the tip of the endpin; this is length (c).

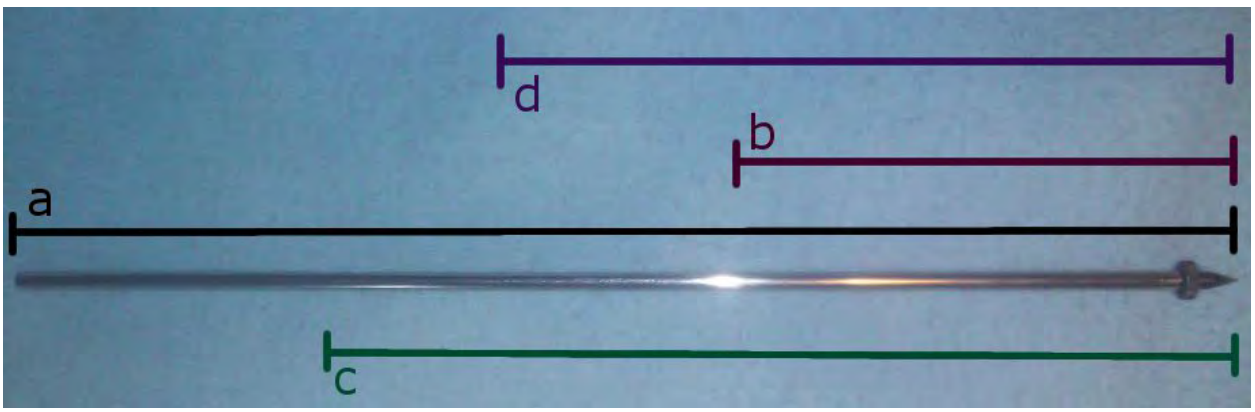

Figure 1 a) total length, b) cellist's clamp point length, c) resonant point length, d) length to cut endpin.

The equation to calculate the optimum length of this endpin for the cellist is:

$$(a*b)/c = d \quad \text{(a times b divided by c equals d)}$$

where (a) is the original length of the endpin, (b) is the length from the cellist's clamp point to the tip of the endpin, (c) is the length from the resonance point to the tip of the endpin and (d) is the new total length of the endpin. Cut the endpin to length (d) plus about an inch to allow for slight adjustments. This will put the resonance point of the endpin at the same place on the endpin as the cellist's clamp point (b). The resonant point is such that more endpin is outside the cello, than inside the cello.

For example, if the endpin is 16″ long and the resonance point is 4″ from the top (¼ of the length of the endpin); then if the endpin is cut to 13″ long (12″ plus an inch), the resonance point will be a little longer than 3″ from the top (also ¼ of the length of the endpin). The pitch at which the endpin rings at will be different but it is still a resonant point.

Thus the endpin should be sized so that the point at which the cellist clamps the endpin is the resonance point of the endpin.

How to hear and feel the CelloStone difference without a CelloStone

To hear and feel most of the changes in the cello, similar to playing on a CelloStone , try this experiment. Find the resonant point of the endpin as discussed above. Clamp the endpin at the resonant point and place the endpin on a piece of carpet or rubber mat on a concrete floor. Find the "wolf note" of the cello and play it. Without moving your finger position, place the endpin on the bare concrete floor and bow the note. Feel and hear the difference.

Next play some fast notes and/or difficult bowings on the piece of carpet or rubber mat, then directly on the concrete floor (in a slight divot or crack). Go back and forth several times to understand the difference.

In general the bow will initiate notes easier and smoother. The voice of the cello will have less of a muting or muffling on the concrete floor.

Basements or garages with slab on grade concrete floors are the best places for this experiment. It will not work on vinyl, tiles, wood or other substance on the concrete slab. Most stone floors will not work except some of the granite or travertine floors. Note that the endpin must be in contact with the concrete floor or CelloStone in order to dissipate the interfering vibration.

The CelloStone is a portable concrete floor.

Travertine

The CelloStones are made of travertine tiles. Travertine comes from various environments, cool streams such as Havasu Creek near the Grand Canyon or in hot springs such as Mammoth

Figure 2a Havasu Falls, Cold water Travertine

Figure 1b Mammoth Hot Springs, Hot water Travertine

Hot Springs in Yellowstone National Park. Each of these environments has a seasonal element which changes the travertine from year to year. Travertines also have a winter-summer or dry season-wet season yearly cycle in their deposition. These cycles also vary from year to year.

CelloStones are from naturally occurring travertine deposits that are cut into 12” tiles at the quarry. The specific type of travertine was chosen for its ability to dissipate the specific interfering energy. The travertine tiles are from streams that flowed over 65 million years ago. The specific travertine for CelloStones was picked for tonal parameters, so they would dissipate a specific polarization of the vibrations. Each set of tiles is tested and then matched to each other. Each finished CelloStone is then matched to a cello.

The parameters that allow the travertine to dissipate a specific polarization of vibrations are not found in other rocks such as Shale, Slate, Granite, Limestone, Marble and clays. Concrete floors have similar parameters to the CelloStone but the floor is not tuned to the cello, so while there is improvement on a concrete floor, there is more improvement when the cello is on a CelloStone. There are a few granites, sandstones and quartzites which could dissipate the energy, but due to mass and size considerations, they are not practical.

Only a few rocks have the ability to dissipate the interfering energy of a cello in a size practical to carry around.

CelloStones remove the vibrations on the surface of the string that interferes with the stick-slip motion of the bow giving faster bow response and reducing a feeling of drag on the bow.

The Geophysicist and the Luthier – learning from each other

The CelloStone came from the collaboration of a luthier and a geophysicist. The unlikely pairing of an artist with an engineer. Both brought to the table a unique set of skills and interests resulting in a unique patented product; which is counter to the current state of the art for the physics of the cello.

In June, 2008, the Geophysicist's family bought their daughter a German made student cello. The luthier made the comment that the old plywood cello could not sound as good as a solid wood one. The luthier explained that the plys of the plywood interfered with the movement of sound in the cello. The geophysicist wondered why the plys interfered, they would not in soils or rocks. This started her reading on acoustics. The more the geophysicist read the more she found that the ideas of how a cello made sound were inconsistent with the plys causing a different sound. In other words, the "conventional wisdom" did not explain the plywood cello.

The geophysicist kept reading hoping to find an explanation that fit the plywood cello. During this time, she become familiar with a significant portion of what had been written on the subject of acoustics of the violin family, the physics of the violin family and some of the acoustics of concert halls. She read about modal analysis, tonal copies, the Hutchins Octet, Helmholtz motion of the string and how Helmholtz motion has been modified. She read C. V. Raman's papers, the wave equation models and how they were derived, the electric circuit models, Oliver Rogers' Finite Element models and the models of the bridge movement with its coupling to the body of the instrument. She read about the search for the specifications for the best tonal woods from which to make violin family instruments and even the history of how the Cremona instruments were saved. She found that the Boulder Library system had access to the Music School libraries at Universities in the most of the States around Colorado and that the University of Colorado Music School library had all the back issues of the Cat Gut Society and Violin Society of America Magazines. The collection of the CV Raman papers were also in the CU archives and available to Boulder Library Patrons.

The more the geophysicist read the more she realized that a geophysicist looked at the physics of the cello from a very different perspective. Geophysical measurements of sound are made in the frequency range of 8 to 150 Hz while the theoretical physicists measured properties of the cello using frequencies between 30,000 to 50,000 Hz. The cello strings range from 65 to 220 Hz. It made sense that her experience with sound was more appropriate than the theoretical measurements.

The Geophysicist listened to the Luthier on what he did to find the best wood and how he knew when the cello was carved to provide the best voice. The current state of the art did not explain how any of what the luthier did could possibly work. She saw that a different explanation of how the cello made sound and it fit what the luthier did.

At that point the luthier discussed a problem he was having. His cellos had little or no wolf in his workshop and significant wolves in the cellist's home or studio. The cello could come back to the workshop and be fine again and the go out to the cellist and the wolves were back. The geophysicist and the luthier discussed the luthier's idea that it was environment, but the wolves returned even in places where the humidity was the same as the workshop. So what was different? Only the floor and floor covering were different. The workshop had a concrete floor and cellists played on carpet or tile floors. Sure enough if the cellist played in the garage or on a concrete basement floor, no matter what the humidity or temperature, the cello performed like in the workshop, almost no wolf. The luthier started using a rubber mat to do the final adjustment so that the cello was the same as in the cellists home; but the luthier preferred the voice of the cello when it was on the concrete floor.

The problem was defined – Find a way to put a 4 foot by 8 foot sheet of concrete under a cellist's arm so the cellist can play on it anywhere.

The problem mulled in the luthier's and geophysicist's heads for nearly a year. The geophysicist looking at dissipating the energy to the floor and the luthier wondering what about concrete was important. The geophysicist talked to other engineering friends and calculated that there needed to be 10″ width of material in order to get the desired effect. The luthier, experimented with some concrete blocks finding that a 20 pound block worked. Problem for the luthier was that the block only worked if the endpin was exactly in the center. Sure enough the length across the block in the shortest direction was 9 ¾″. The 10″ calculation seemed to be correct. This sent the geophysicist on a shopping trip to all the stone tile stores in the area. Finally she found the travertine tile she was looking for at a small flooring store and bought some travertine tiles that tonally matched each other. Next she took them to her cellist friends and got them to play on the tiles determining that it would take two tiles and that a 10″ square on a 12″ square tile would work. The geophysicist hoping to find a ¾″ thick rather than two tile solution, found a counter top of travertine and had 10″ and 12″ disks made. But they did not work as well as the tiles. The CelloStone was born.

The initial CelloStone testers, all of which were cellists making their living playing cello, were impressed that the cello's "wolf note" did not return even with changing temperatures and humidity. Taking the cello on tour did not bring the changes in the "wolf note" it usually did. What was learned in the practice room at home worked where ever the cello went as long as the endpin was on the CelloStone. Having the cello heat up under the lights on stage was no longer brought back or moved the wolf. The cello stayed the same (only the cellist was wilting). Other early testers found that the CelloStone made the bowing smoother meaning that when the symphony started having two practice sessions a day, their bow arm no longer became so tired it ached.

As the luthier and the geophysicist worked with the CelloStones they found that different cellos matched different tiles, and that the tiles did not all match each other. In fact, finding two that matched required checking several different tiles. The geophysicist also showed the luthier that the travertine tiles picked worked but limestone, other travertines, granite, clay, marble, shales and clay tiles did not work. So it was like wood - you couldn't just go to a lumber store and buy cello wood and you couldn't just go to a flooring store and buy travertine. It was obvious they needed to buy all the travertine tiles in the lot from the flooring store. The travertine from this quarry is a "tone stone". As the luthier put it "they bought the whole tree after finding it was a good one".

The geophysicist will find more travertine tone stones after this supply is gone. The geophysicist also showed the luthier that even though this set of travertine is from one quarry and one part of the quarry, only about two thirds of the tiles are able to be CelloStones.

Deborah Miles Biographical information

She received a Bachelor of Science (BS) in Math and Geology from Portland State University and a Masters of Engineering (ME) in Geophysics from Colorado School of Mines. She is a Registered Professional Engineer (PE) in Colorado and a Registered Geologist (PG) in Wyoming. For over 30 years she interpreted seismic data (mostly compressional waves - acoustic waves, if they are in air) as it pertains to exploring for hydrocarbons. She worked with compressive data to understand the shear wave information of the rocks, which give clues to the presence of hydrocarbons. She has authored and presented 14 papers on different aspects of interpretation and understanding compressional waves and how they relate to shear wave data to the Society of Exploration Geophysicists (SEG) International meetings, European Association of Exploration Geophysicists (EAEG) meetings, Australian Association of Exploration Geophysicists (ASEG) meetings, SEG Summer Research Workshop and to SEG chapter meetings. Many of these papers were invited and some were awarded best paper. In addition, she taught a three-day course on seismic interpretation requested by the SEG. Much of her work with compressional waves was involved with gleaning shear wave information from the compressional waves. She also worked as a Geotechnical Engineer, mapping soils for foundations and drainage in the housing industry.

Deborah is married with one daughter. Deborah, her husband and daughter are volunteers with the Loveland Ski Patrol. She is the CPR Advisor and a Mountain Travel and Rescue Instructor for the ski patrol. She teaches Cardio Pulmonary Resuscitation (CPR) for the Red Cross and the Loveland Ski Patrol. She is an avid hiker in the summer, skier in the winter.

The Patent

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Miles

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(45) **Date of Patent: May 27, 2014**

(54) **PORTABLE DISSIPATING MEDIUM USED FOR REMOVAL OF VIBRATIONAL INTERFERENCE IN A BOWED STRING OF A VIOLIN FAMILY INSTRUMENT**

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See application file for complete search history.

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(57) **ABSTRACT**

A dissipating medium made of a stone-like tile. The tile used for removing a wolf note and its related energy, when played on a string musical instrument. The tile is made of a natural mineral, such as travertine. Also, the tile has a shear wave velocity between 300 to 440 m/sec. The tile can have an angular or annular shape. The angular shape is in a range of 10 to 12 inches square and a thickness in a range of ½ to ¾ inch. A top surface of the tile includes an annular depression for receiving an end pin of a cello's tail piece. The medium can be constructed of two tiles with an upper tile 10 inches square and a lower tile 12 inches square. Also, the medium has a weight in a range of 6 to 12 pounds for ease in transporting.

15 Claims, 2 Drawing Sheets