Meandering rivers, the veins in your arm and lightning: what do these have in common??

*Answer: all have similar properties to the way forces are transmitted through a granular material!*

My name is Maya Muthuswamy, and I’m a PhD student studying the mechanics and modelling of granular materials under the supervision of Dr. Antoinette Tordesillas. An interesting property of granular materials is the way stresses are transmitted – these ‘lightning-like’ pathways are commonly called **force chains**. The below picture (taken from http://exploration.grc.nasa.gov/6712/comflu/GGM_intro.html) shows a Couette shear device filled with photoelastic disks that light up when stressed – clearly showing the force chains.

We used a numerical modelling technique for granular materials called the ‘discrete element method’ (DEM), which simulates the behaviour of each individual particle. The experiment we looked at was a rigid flat punch indenting a bed of granular material (applications: foundations of buildings, penetration). Here’s the punch before it has indented. Particles are coloured by their ‘stress’ (similar to the picture at left). Try and count the force chains!

Now here’s a picture showing the same setup, after our method for quantifying force chains has been applied: only those particles that are red are part of force chains.

Finally, here’s the punch after it has indented, showing the evolution of the force chain network: as you’d expect, force chains emanate from the base of the punch radially outwards, to support the applied load.

This method of force transmission is one of the many peculiar and unique aspects of granular material, which makes it all the more surprising that there is currently no quantitative, agreed definition of what a **force chain** actually is!

Over the summer of 2004-2005, I was lucky enough to spend 2 months in the US working with Dr. John Peters at the US Army Engineer Research and Development Centre, where we came up with a method to quantify and hence count precisely how many force chains we have in a given system.

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