Product review and comments on electronic core orientation – IMDEX's paired ACTx and Smart Jig tools

This week I had the pleasure of Mark Gabbitus (IMDEX Ltd Head of Product) hosting me for a tour of IMDEX's Balcatta facilities and getting a demonstration of their new ACTx digital core orientation tool and its spouse, the Smart Jig (yes, every gizmo, device, and gadget must have a name).

As many people will know, I am pretty vocal about getting quality structural geological data from diamond drill core. There are many reasons this can be compromised, and this can be broken down into how the core is treated in the several main steps of the process:

- Ascribing a high-quality orientation to the core after drilling and before it has been removed from the core barrel.
- Auditing of core integrity after it has been removed from the barrel to see if there is continuity e.g. checking apparently coherent core across breaks that may have accommodated core-spin.
- Accurate core assembly and marking up of the orientation line, ensuring good locks between intervals, reassembling/gluing core across zones of fracturing etc. There is a whole industry that has been spawned and developed around the assessment of this.
- Extraction of accurate data utilising core frames, manual alpha-beta devices, electronic alpha-beta devices, and virtual logging from photographs. Once again, whole industries have evolved around this. This is where the use of core orienting frames is vital for checking alpha-beta data, for visualising geometric/orientation relationships, measuring lineations, and working proficiently with half-core. Note that all the people I know who use a core orienting frame also use alpha-beta devices, utilising whatever works best at the time. Conversely, alpha-beta advocates rarely if ever use a core frame. Anyway, that's a digression and a comment to ensure I get the maximum volume of rotten vegetables hurled at me.
- Auditing of the structural data to see that it 'makes sense'. This entails, but should not be restricted to, assessing data distributions on a stereonet and in 3D. A check of orientations calculated from alpha-beta versus those measured directly is helpful in this regard.

In terms of the first stage of the process mentioned above, namely ascribing an initial orientation mark to the core, I've reviewed core orientation procedures since the earliest references I can find, which were back in the late 1800s. Over time, there have been regular changes and improvements, such as going from a spear to a mechanical device (e.g. Ballmark) to a mechanical device where an indication of tool function was given during the orientation process (Ezy-Mark) to electronic devices (e.g. the ACT tools). I've also spent a lot of time (so much time!) working with oriented core and auditing the data and orientation quality. Along the way I have written articles on oriented core, become an editor to the world's largest virtual drilling publication (Coring Magazine), been involved in the early stages of product development of the iQ-Logger, and test-driven some of the earliest virtual structural logging software (UPC's ScanIT).

Electronic devices have now cornered the market, and there really hasn't been any major step-changes for a while. Sure, the devices have become more sophisticated in terms of their tolerance to environmental conditions, accuracy with steep holes and ability to electronically transfer the orientation and structural data. This pertains to both the orientation devices and the

electronic loggers, such as IMDEX's iQ-Loggers. As an aside, much of the evolution of the electronic core orientation industry has involved the swallowing up of, or legal battles over, competitor systems, such that IMDEX is now the industry giant in terms of core orientation and integrated systems for data acquisition and analysis.

So, cutting to the main thread of this post. Before I start, I'm not getting paid for this – just giving my views. IMDEX has a new digital core orientation tool, the ACTx, as part of its end-to-end solutions to aid drilling optimisation and assisting fast (not necessarily a good thing – it's not a race) data collection and analysis. Coupled with this is the new Smart Jig tool, which initialises between the ACTx unit attached to the barrel via infra-red, with signals sent through the water ports, prior to drilling a run. The Smart Jig is a light unit that is comfortable to hold. Turns out, IMDEX engaged a holding-grabbing consultant to make the unit ergonomically nice. The two things that make the Smart Jig a much easier and better unit than previous versions are the visual display for orienting the barrel (remember, we are orienting the barrel, not the core, and transferring a mark to the core) and the jig for controlling the wax crayon used to mark the core. Note also, that the new ACTx device attached to the barrel is much smaller than previous versions, removing the need for extension barrels. It also has custom couplings that allow swapping between HQ, NQ and NQ2 in the field.

The entire kit. The Smart Jig is sitting in docking groove on the ACTx attached to the core barrel. A tough tablet is paired to the devices and a sleeve for the Smart Jig for different core sizes sits in front of it. A piece of bent metal with an IMDEX logo sits behind the latest version of the blue iQ-Logger. The red box is the Smart Jig – ACTx kit with couplings etc.

After initialisation, the run is drilled. Once the core has returned to the surface, the handheld Smart Jig device slides over the down-hole end of the barrel and the visual display shows two or more green lights and a blue light on a circular display. The trick now is to rotate the barrel so that the blue light (the ball) ends up between the green lights (the goal posts).

Time for orientation soccer. The Smart Jig is rotated (not the barrel) until the blue light goes through the green goal.

As the barrel is rotated back to its orientation at the time the reading was made (i.e. the internal accelerometers in the ACTx indicate that the tool is in the same position to register 'down' as it was when drilling ceased and the reading taken), the number of green lights increases. When back to the original position, all the green lights on the display will show.

Two photos showing progressive rotation of the Smart Jig and the increasing number of green lights as the original barrel orientation is approached. Final orientation is achieved when a full ring of green lights is present.

At the point where a ring of green lights is showing, the wax crayon is inserted into the custom slot in the Smart Jig, which stops the person marking it from angling the pencil or drawing an inclined line. There is facility to use a custom slot on the side of the device to mark the edge of the core as well. Turns out that there is more than one diameter of wax crayon in the world – who'd have thunk it?! So, the kit comes with a batch of adaptors to fit your pencil (no innuendo intended), depending on where you are in the world. The Smart Jig works with the ACTx down-hole unit to not only make it harder to put a bad orientation mark on the core, but the system also collects QA data about the orientation and marking process that the geologist can access in IMDEXHUB-IQ (yes, another capitalised system name!).

As part of the orientation process, the inbuilt QA functionality in the Smart Jig lets the driller enter information for each orientation. Some of this may be useful if an orientation is considered suspect when reviewing core at the mark-up or data collection stages. This digital step is an addition to (it shouldn't be a replacement for) scribbles on core blocks, the side of the core, or written with a thumbnail dipped in driller's grease on the paper plod.

So, the advantages of the new system are:

- Improved core marking process using the Smart Jig makes it harder for the driller/offsider to put the mark in the wrong location on the core face. This is especially evident when you have challenging core marking situations such as wedgy core or core that has broken inside the lifter case.
- QA data for both the driller and geo about the quality of the orientation measurement down hole (i.e. was there movement of the rig during the measurement period) and the quality of the orientation mark. The ability to add comments by the driller plus the QA

data for each run will help the geo understand when issues arise and how much confidence to assign to the orientation mark.

- From a driller's perspective, they will benefit from a smaller ACTx device, no need for extension barrels, and the ability to field swap couplings from HQ to NQ/NQ2 in a single kit. Additionally, the reduced manual handling of the core tube during the orientation process is a safety benefit for the drillers.

In addition to the new iQ-Logger, I was shown the latest version of the iQ-Logger. To be honest, I didn't notice much difference, but apparently it is better to hold than the previous version, thanks again to the holder-grabber consultant. The buttons are in new places and more functional, so that's an improvement. Symbols embossed into the plastic were hard to read though (not just because of my eyes – I was wearing glasses).

So, my overall assessment is that this is an elegant system and a big step forward in terms of getting an orientation mark on the core. I hesitate to say it gets a good orientation mark because we still have the issue of the system being an electronic back-end device. So, we will always get a mark on the core because we are always orienting the core barrel, not the core, and transferring the mark from the device (the Smart Jig in this case) to the core. There is no way of knowing how much the core has rotated, spun etc in the barrel prior to orientation. We can only assess this after removal of the core from the barrel after the orientation process. In the old front-end devices, and the spear, the core stub attached to the rock was marked prior to drilling a run. That is, there is no rotation of the initial core in the barrel prior to orientation. This can be a distinct advantage in broken ground where there is a propensity for core to spin in the barrel as the run is drilled, especially in cases where structures being intersected are at near right-angles to the drill-hole (these facilitate ease of core-spin). So, there is your challenge IMDEX – provide an electronic device that gives an orientation of the core stub prior to drilling the run.

The other problem that has nothing to do with the orientation devices, is that of knowing what you are logging. I guarantee that most geologists could not give a snapshot geological history of the deposits they are logging, which would identify different structure populations and their relative ages. So, data sets get mixed, time is wasted logging economically unimportant structures, economically significant structures are misidentified, or not logged, and final data sets are less useful than they could be. Lineations are typically ignored. And then there are people who don't understand that best geological understanding comes from marrying information from all sources, not just the one they are familiar with. Case in point, I had the experience of receiving this comment (after my work had been done but disregarded by this guy) pertaining to a multi-million ounce, structurally controlled hydrothermal Cu-Au system – *"The structural part remains to be integrated, though I am strongly of the opinion that we can't let that nnecessarily[sic] complicate the deposit and exploration model"*. Don't be like this guy! We have enough challenges to understand deposits, and people like IMDEX have invested an incredible amount of money into getting us high-quality oriented core, without ignoring entire datasets and geology disciplines because we are pandering to someone's naivety /arrogance.