X-rays for gold

China and Australia are the world's two largest producers of gold. So, it's fitting that a device combining Australian and Chinese research, and capabilities in high-tech manufacturing, is set to shake up the industry.

Ore processors need to know how much gold is in their raw material to get the most out of it. The current industry standard for testing ore is the fire assay, an elaborate and time-consuming process that requires temperatures over 1000 degrees and toxic chemicals such as lead. It also takes at least 8 hours to complete.

That's where the PhotonAssay machine comes in. Built by Adelaide's Chrysos Corporation and Beijing's Nuctech Company, it uses a two-minute X-ray scan to determine how much gold is in a sample of ore with an accuracy of less than one part in a million.

The concept was developed over a decade by James Tickner and colleagues at CSIRO: you bombard the ore with high-energy X-rays, and then identify gold by the characteristic gamma-ray echo it gives off in response.

The idea had such potential that a new company, Chrysos, was formed to develop it. For manufacturing smarts, James turned for assistance to Nuctech, a world-leading maker of security scanners. He has worked with the Chinese company since 2007, when they collaborated with CSIRO to produce an innovative neutron-based scanner for air cargo.

The air cargo scanner project led to other cooperative research and development projects. Over the years, James has made dozens of trips to visit Nuctech's Beijing headquarters and their development and production facility in Miyun.

Teaming up with Nuctech engineers, Chrysos developed a design for the PhotonAssay machine in early 2017. Just over a year later, the first device began operation in Perth.

Another two PhotonAssay machines will be deployed in the first half of 2019, and after that Chrysos will ramp up production.

"Nuctech have given this project all the resources it needed to succeed," says Chrysos CEO Dirk Treasure. "There's no better party we could have chosen to work with."

Making mines safer

Huainan Coal Mining Group is going deeper each year in the search for coal. Its miners are often working at depths of nearly a kilometre. Australia's CSIRO is working with them to ensure the safety of the mines.

Coal seams in the Huainan area are highly gassy. That creates two major risks: explosive outbursts of coal and gas; and concentrations of methane gas.

Traditionally miners have dealt with the methane after it has been released. The Huainan and CSIRO engineers looked at the problem differently and have developed a system that enables them to drain methane from the coal seam. This approach was used at the Huainan Pansan mine and generated a consistent, high flow rate of high purity gas. It also helped CSIRO develop a similar approach for the Bulga coal mine in eastern Australia.

The Huainan and CSIRO team have also demonstrated that waste methane gas could be used to produce electricity using a novel catalytic combustion gas turbine system.

Automation for safety

Most underground coal mines use longwall mining. Typically, a seam of coal is mined in a series of one metre slices, taken from a block of coal that's kilometres in length and hundreds of metres deep. The coal is carried away on a belt, and the roof of the mine is held up over the top of the equipment by large hydraulic rams. This mining system has made mines safer, but it still puts miners close to big, violent machines. "So, we worked with industry to create an underground automation system that isolates people from mining hazards while improving productivity," says CSIRO's Dr Mark Dunn. The machine knows where it is to the nearest centimetre using a built in guidance system that works underground. The system can be managed by an operator in the mine, on the surface or on the other side of the world.

Sixty per cent of Australia's underground coal miners already use the CSIRO technology. China's biggest miner, the China Energy Investment Corporation (China Energy) , has installed five systems and China Coal Technology and Engineering Group is working with CSIRO to make the technology available to the 1,500 longwall mining sites in China.

Photos: English and Chinese side, top left, PhotonAssay system quickly tests gold ore: Chinese side, top right, longwall automation at work, (CSIRO) all other images courtesy Shutterstock.

For further information visit www.china.embassy.gov.au

Australian Government

MINING EQUIPMENT, TECHNOLOGY AND SERVICES

X射线探金

中国和澳大利亚是全球最大的两个黄金生产国。因此，一套结合澳大利亚和中国研究成果以及高科技制造能力的设备即将为整个行业带来巨变。

矿石加工方需要了解原材料中的黄金含量以使产量最大化。目前测试矿石的行业标准工艺是火试金法，其流程复杂且耗时，需要用到1000度以上的高温和铅等有毒化学物质，并且至少要8个小时才能完成。

这时PhotonAssay出现了。这台仪器由阿德莱德的Chrysos公司和北京的同方威视技术公司联手打造，通过两分钟的X射线扫描来确定矿石样品的金含量，误差率小于百万分之一。

澳大利亚联邦科学与工业研究组织（CSIRO）的詹姆斯•蒂克纳（James Tickner）和他的同事们曾研究这个概念十多年：先用高能X射线轰击矿石，然后通过黄金特有的伽马射线反射来探测其含量。

此概念的巨大潜力带来了一家全新的公司Chrysos来专注其开发工作。为了制造智能设备，詹姆斯向世界领先的安检扫描仪制造商同方威视寻求协助。2007年，CSIRO曾与这家中国公司合作生产了一种创新型航空货物中子扫描仪，当时詹姆斯也曾和这家公司合作。

航空货物扫描仪项目带来了更多的合作研发项目。这些年来詹姆斯已经访问过同方威视北京总部及其密云开发生产基地数十次。

通过与同方威视工程师的合作，Chrysos于2017年初开发出PhotonAssay的设计图。仅仅一年多以后，第一台设备就在珀斯投入了运营。

另外两台PhotonAssay将于2019年上半年安装好，随后Chrysos将扩大该设备的产量。

“同方威视为这个项目提供了成功所需的一切资源，”Chrysos的首席执行官德克•特雷杰（Dirk Treasure）说，“再也找不到比他们更好的合作伙伴了。”

让采矿更安全

每年，淮南矿业集团的煤炭开采都更深入地下。煤矿工人经常在地下一公里左右工作。CSIRO正在与其合作，确保矿区安全。

淮南地区的煤层内含有大量燃气。这将导致两类风险：煤和天然气剧烈爆炸以及甲烷聚集。

传统煤矿作业人员一般会在甲烷气体释放后再对它进行处理。淮南矿业和CSIRO的工程师们却独辟蹊径，开发出了从煤层中排出甲烷的系统。淮南矿业潘三煤矿采用这种方法稳定产出大量高纯度气体。 CSIRO还据此为澳大利亚东部的巴尔加煤矿研发出了类似的方法。

淮南矿业和CSIRO的团队还验证了利用新型催化剂燃气轮机系统和废甲烷发电。

自动化确保安全

绝大多数地下煤矿采用长壁采煤法。通常情况下，煤层开采取自长度几公里、深达数百米的煤矿中一系列一米的煤层。当煤矿石被输送带运走后，矿井的顶部由大型液压油缸撑在设备上方。

尽管这种采煤系统提高了采煤的安全性，但煤矿作业人员仍然处于高危大型机械附近。“于是我们与业界合作推出了一种既能使作业人员远离采矿风险又能提高生产力的地下自动化系统，”CSIRO的马克•邓恩（Mark Dunn）博士表示。利用可在地下工作的内置引导系统，这种机器可以精确定位到厘米。操作员可以在矿井中、地面上甚至世界另一端来操控该系统。

CSIRO的这项技术已经被60%的澳大利亚地下煤矿采用。中国最大的煤业公司——国家能源投资公司已经安装了五套该系统；中国煤炭科工集团也在与CSIRO合作，为中国1500个长壁采煤煤矿提供该技术。

中英版左上角：PhotonAssay快速检测金矿；中文版右上角：长壁自动化系统在工作（图片来自CSIRO）；其他图片鸣谢Shutterstock

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澳大利亚政府

采矿设备、技术与服务