

# What is Archaeomagnetism?!

**MANGA:**  
**HAYANON+**  
**SCIENCE MANGA STUDIO**  
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(Nagoya University)



NAGOYA UNIVERSITY



Institute for  
Space-Earth  
Environmental  
Research



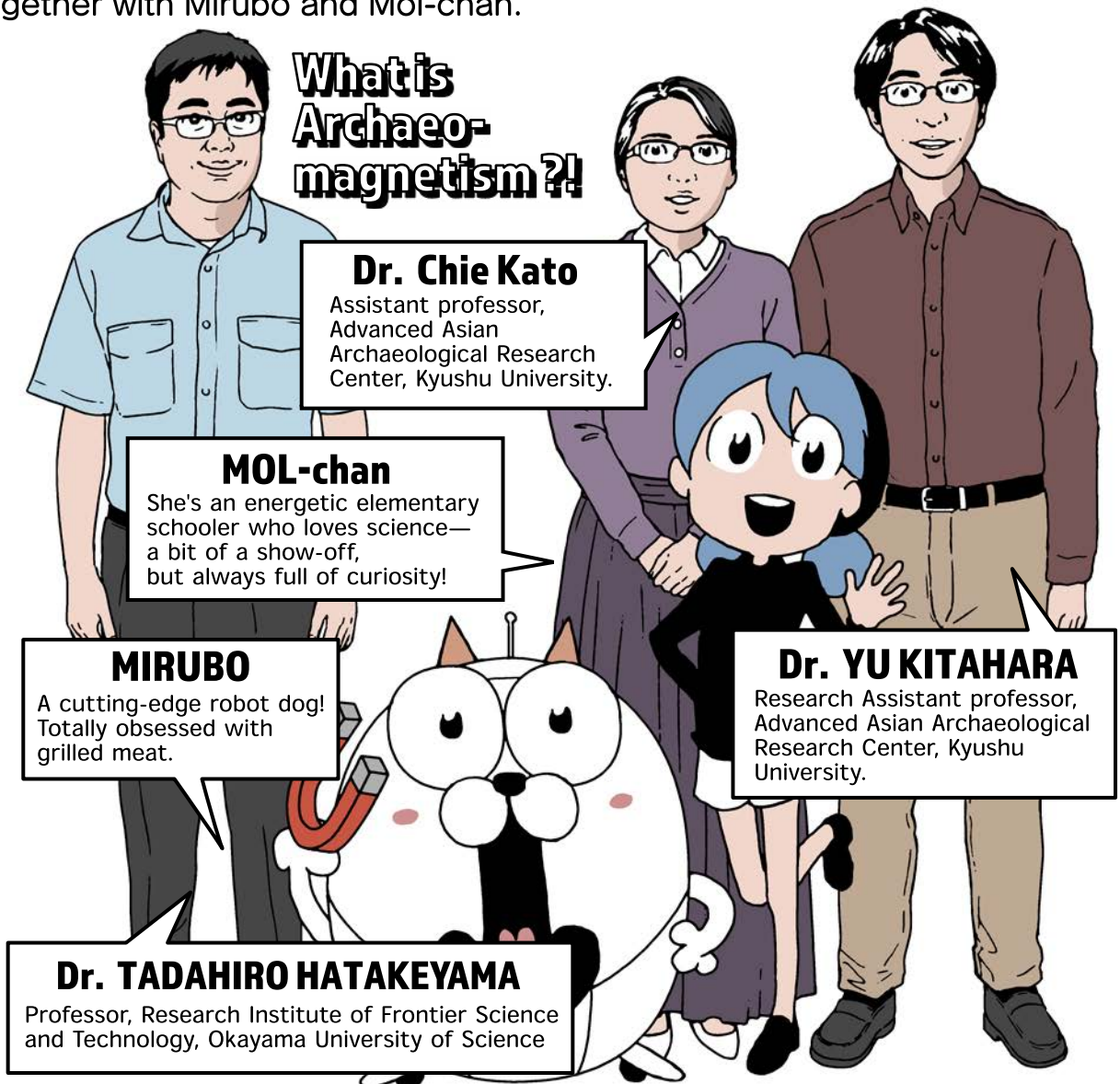
TRAN SEHA  
Transdisciplinary Network for Space-Earth and Human Activities



Scientific Committee on Solar-Terrestrial Physics



The Earth is often described as a “giant magnet”. A compass needle points north because of the force known as the Earth’s magnetic field. Over long periods of time, the direction and intensity of this magnetic field slowly change. Archaeomagnetism is the study that uses these changes in the Earth’s magnetic field to determine when artifacts such as pottery, roof tiles, and burnt soil found at archaeological sites were made. Tiny magnetic minerals inside these materials record the direction and intensity of the Earth’s magnetic field at the moment they were fired. By studying this magnetic record, researchers can learn about past human activities as well as changes in the Earth itself. In this comic, let’s take a look into the world of archaeomagnetism together with Mirubo and Mol-chan.



I'M MIRUBO,  
THE PRESIDENT!  
I BUILD BUILDINGS  
ALL OVER THE WORLD  
AND I'M FILTHY  
**RICH!**

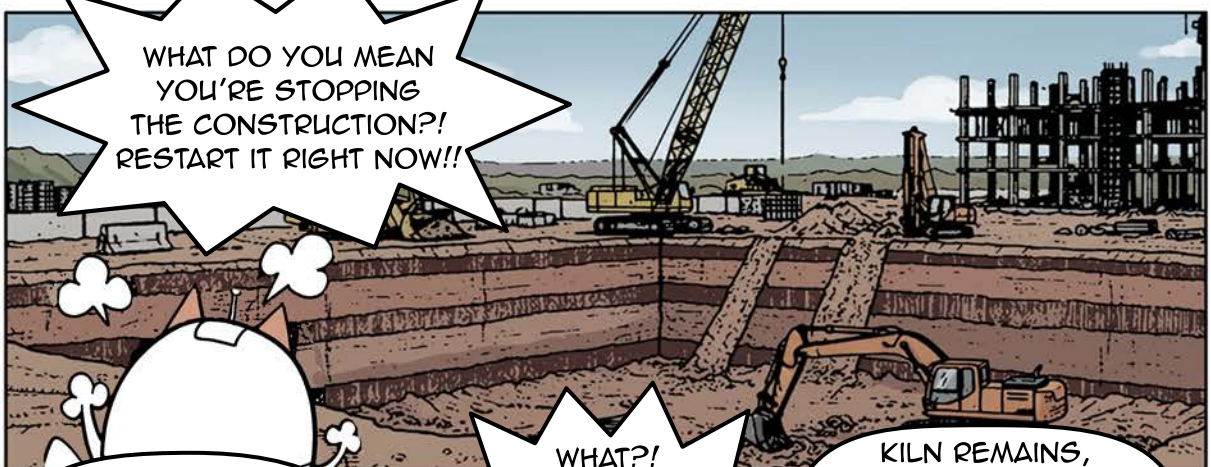
**HA HA HA!**  
KEEP  
THE CONSTRUCTION  
GOING!  
THIS IS MAKING ME  
A FORTUNE!

PRESIDENT MIRUBO,  
WE HAVE A SERIOUS  
PROBLEM.

AN ARCHAEOLOGICAL  
SITE HAS BEEN FOUND  
DURING EXCAVATION.  
WE NEED TO STOP  
CONSTRUCTION  
RIGHT AWAY.

AN  
ARCHAEOLOGICAL  
SITE?!

WHAT DID YOU  
JUST SAY?!  
I'LL GO SEE  
THE SITE!  
MYSELF!



WHAT DO YOU MEAN  
YOU'RE STOPPING  
THE CONSTRUCTION?!  
RESTART IT RIGHT NOW!!!

THIS IS THE REMAINS  
OF AN OLD KILN  
THAT PEOPLE USED  
LONG AGO.  
PLEASE WAIT UNTIL  
OUR INVESTIGATION  
IS FINISHED.

WHAT?!  
IT JUST  
LOOKS LIKE  
ORDINARY  
GROUND TO  
ME!!

KILN REMAINS,  
AND THE POTTERY  
FOUND THERE,  
GIVE US IMPORTANT  
CLUES  
ABOUT HOW PEOPLE  
LIVED IN THE PAST.

IT MIGHT EVEN  
TURN OUT TO BE  
A HISTORICALLY  
SIGNIFICANT  
TREASURE.



WHAT?!  
A  
TREASURE?!

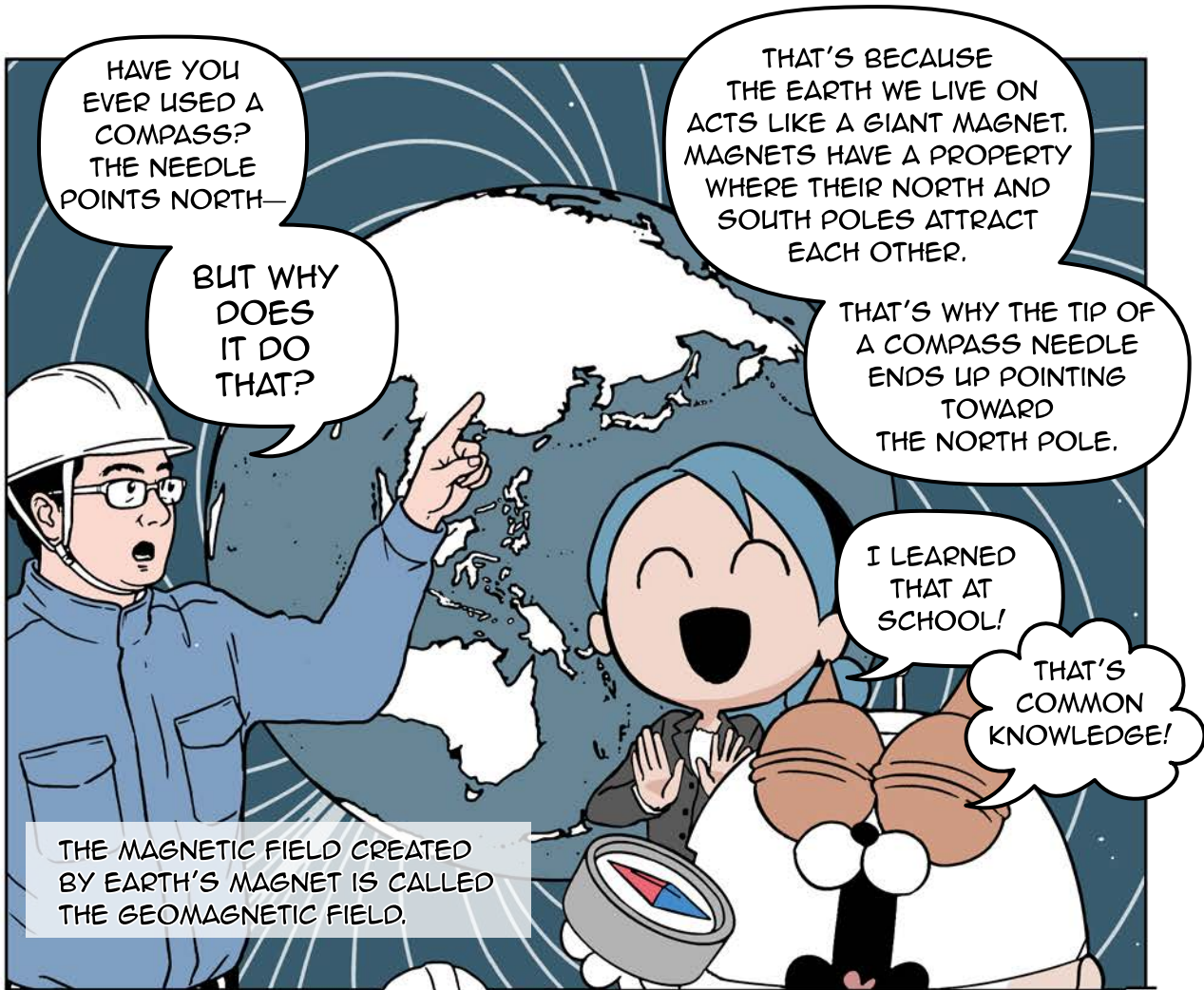
A TREASURE,  
YOU SAY...?  
I WANT TO HEAR  
MORE ABOUT THIS!

WHAT A  
SUDDEN  
CHANGE  
IN ATTITUDE!



WE ARE RESEARCHERS  
IN A FIELD CALLED  
ARCHAEOMAGNETISM,  
WHICH STUDIES THE  
MAGNETIC SIGNALS  
PRESERVED IN  
KILN REMAINS AND  
POTTERY.

USING  
MAGNETISM,  
WE SEARCH FOR  
"TREASURES" OF  
THE PAST.





HAVE YOU EVER  
PLAYED  
WITH A MAGNET  
AND IRON  
SAND?

THOSE TINY  
BLACK GRAINS  
THAT STICK TO  
A MAGNET!

THE POTTERY AND  
KILN REMAINS  
WE STUDY HERE—  
INCLUDING  
THE BURNT SOIL—  
ALSO CONTAIN EXTREMELY  
SMALL PARTICLES,  
MUCH LIKE IRON SAND.

THESE TINY GRAINS  
ARE ALSO  
**MAGNETS.**

A MAGNET  
POINTS TOWARD  
MAGNETIC NORTH!

SO  
WHEN POTTERY  
OR SOIL IS  
HEATED TO HIGH  
TEMPERATURES,  
THE TINY MAGNETIC  
GRAINS INSIDE  
RECORD  
THE EARTH'S  
MAGNETIC FIELD AT  
THAT TIME—  
ITS DIRECTION AND  
ITS INTENSITY!

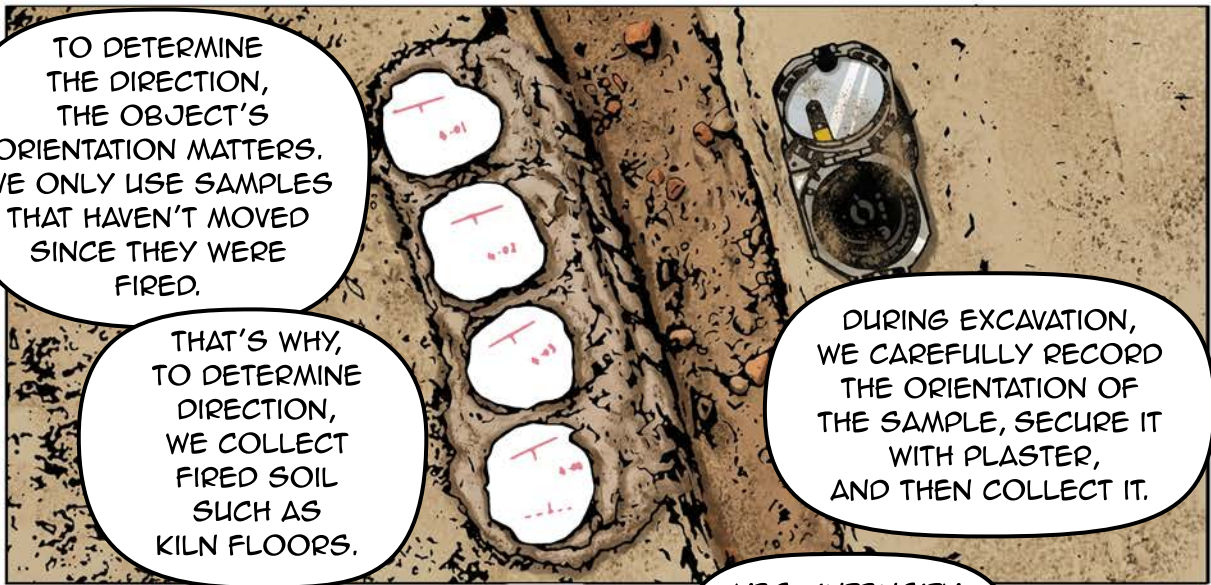
BY ANALYZING THIS  
MAGNETIC RECORD  
IN DETAIL,  
WE CAN ESTIMATE  
WHEN THE POTTERY  
OR KILN  
WAS FIRED.



I SEE—  
SO WHEN  
SOMETHING LIKE  
THAT TURNS UP  
DURING  
CONSTRUCTION,  
YOU STOP AND  
INVESTIGATE IT.

BUT HOW DO YOU  
ACTUALLY STUDY  
IT?!

WE BRING  
THE FIRED MATERIAL  
BACK TO THE LAB  
AND MEASURE  
ITS MAGNETISM.  
FROM THAT,  
WE EXAMINE  
THE DIRECTION AND  
INTENSITY OF THE TINY  
MAGNETS INSIDE THE  
OBJECT!



TO DETERMINE  
THE DIRECTION,  
THE OBJECT'S  
ORIENTATION MATTERS.  
WE ONLY USE SAMPLES  
THAT HAVEN'T MOVED  
SINCE THEY WERE  
FIRED.

THAT'S WHY,  
TO DETERMINE  
DIRECTION,  
WE COLLECT  
FIRED SOIL  
SUCH AS  
KILN FLOORS.

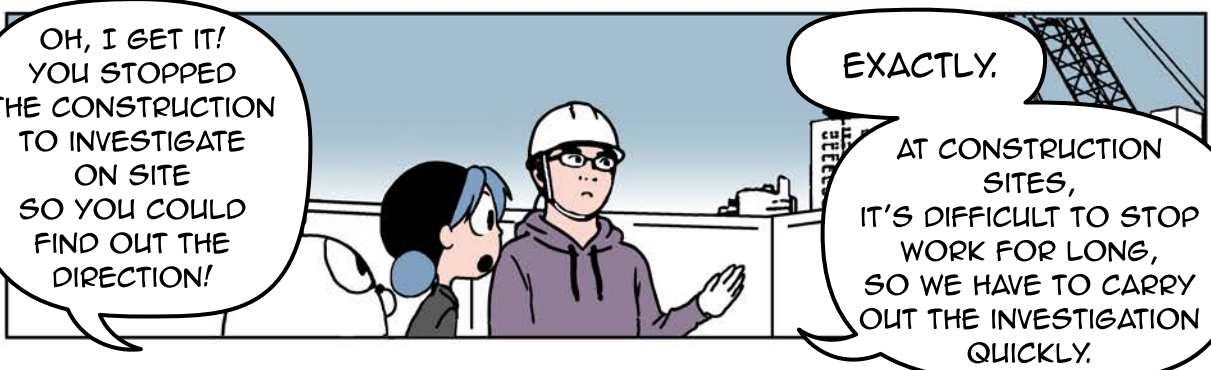
DURING EXCAVATION,  
WE CAREFULLY RECORD  
THE ORIENTATION OF  
THE SAMPLE, SECURE IT  
WITH PLASTER,  
AND THEN COLLECT IT.



CAN YOU STUDY  
POTTERY TOO?

YES—INTENSITY  
CAN BE MEASURED  
EVEN FROM  
POTTERY  
FRAGMENTS.

INTENSITY  
DOESN'T DEPEND ON  
ORIENTATION,  
SO EVEN MOVED OBJECTS  
CAN BE USED.



OH, I GET IT!  
YOU STOPPED  
THE CONSTRUCTION  
TO INVESTIGATE  
ON SITE  
SO YOU COULD  
FIND OUT THE  
DIRECTION!

EXACTLY.

AT CONSTRUCTION  
SITES,  
IT'S DIFFICULT TO STOP  
WORK FOR LONG,  
SO WE HAVE TO CARRY  
OUT THE INVESTIGATION  
QUICKLY.

ONCE WE COLLECT THE SAMPLES AND BRING THEM BACK TO THE LABORATORY, WE USE MAGNETOMETERS TO MEASURE THEIR MAGNETIZATION.

MAGNETIZATION IS A MATERIAL'S MAGNETIC "DIRECTION" AND "INTENSITY".

IF THE MAGNETIZATION IS STRONG, WE USE A SPINNER MAGNETOMETER.

IF THE MAGNETIZATION IS EXTREMELY WEAK, WE USE A SUPERCONDUCTING MAGNETOMETER, ALSO KNOWN AS A SQUID MAGNETOMETER.

VOLCANIC ROCKS.

SEDIMENTS OR SINGLE MINERAL CRYSTALS.

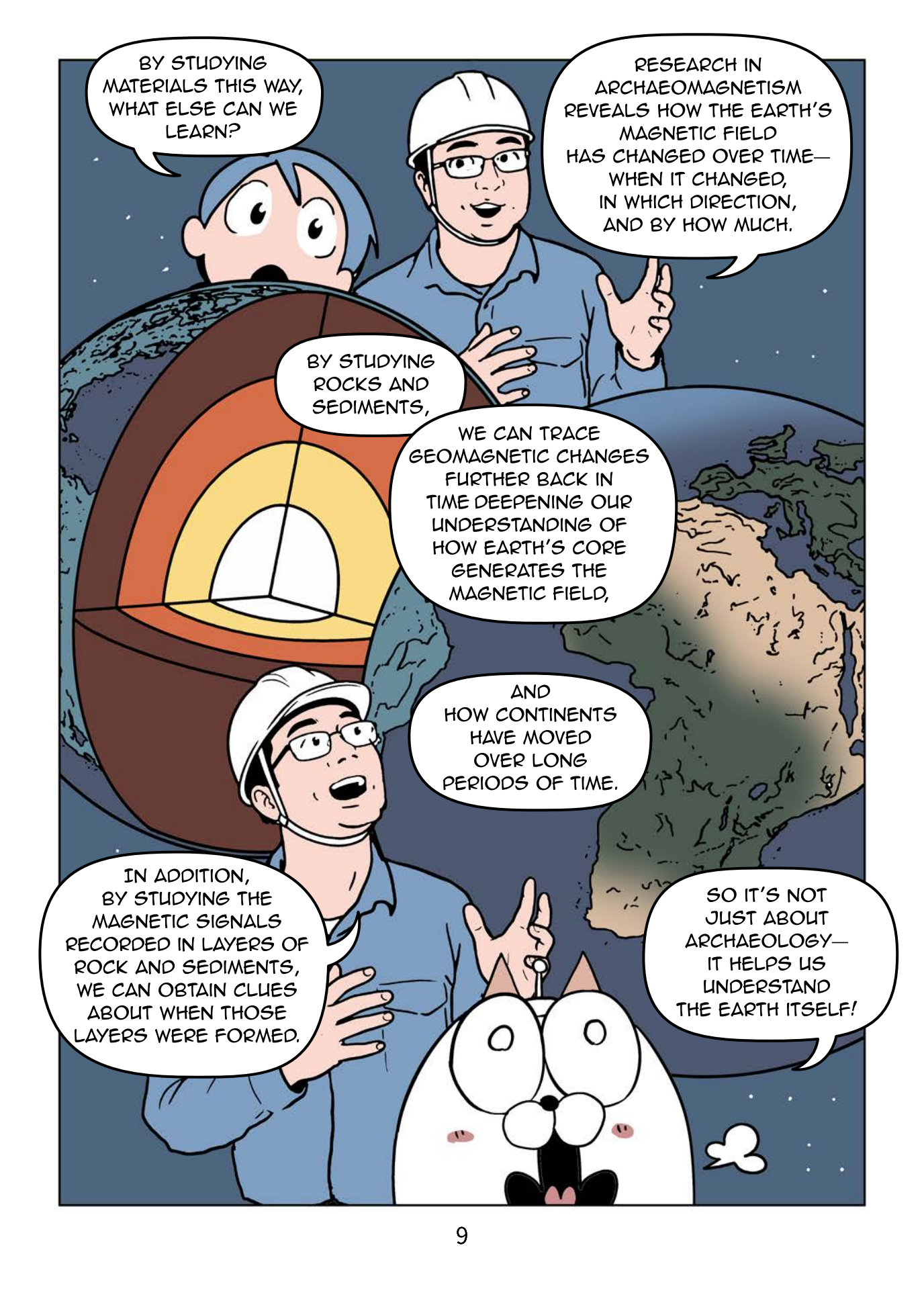
HOWEVER, TO STUDY THE ANCIENT EARTH'S MAGNETIC FIELD—ITS DIRECTION AND INTENSITY—WE CANNOT SIMPLY MEASURE THE MAGNETIZATION AS IT IS.

THAT'S BECAUSE THE SAMPLE MAY HAVE GAINED ITS ORIGINAL MAGNETIZATION WHEN IT WAS FIRED, AND LATER ACQUIRED ADDITIONAL MAGNETIZATION THROUGH REHEATING OR CHEMICAL CHANGES.

TO REMOVE THESE LATER EFFECTS, WE APPLY A PROCESS CALLED DEMAGNETIZATION, WHICH ACTS AS A KIND OF MAGNETIC CLEANING.

FINALLY, WE COMPARE THE DIRECTION AND INTENSITY OF THE RECOVERED MAGNETIZATION WITH RECORDS OF GEOMAGNETIC VARIATION.

THIS ALLOWS US TO ESTIMATE WHEN THE SAMPLE WAS FIRED.



BY STUDYING  
MATERIALS THIS WAY,  
WHAT ELSE CAN WE  
LEARN?

RESEARCH IN  
ARCHAEOMAGNETISM  
REVEALS HOW THE EARTH'S  
MAGNETIC FIELD  
HAS CHANGED OVER TIME—  
WHEN IT CHANGED,  
IN WHICH DIRECTION,  
AND BY HOW MUCH.

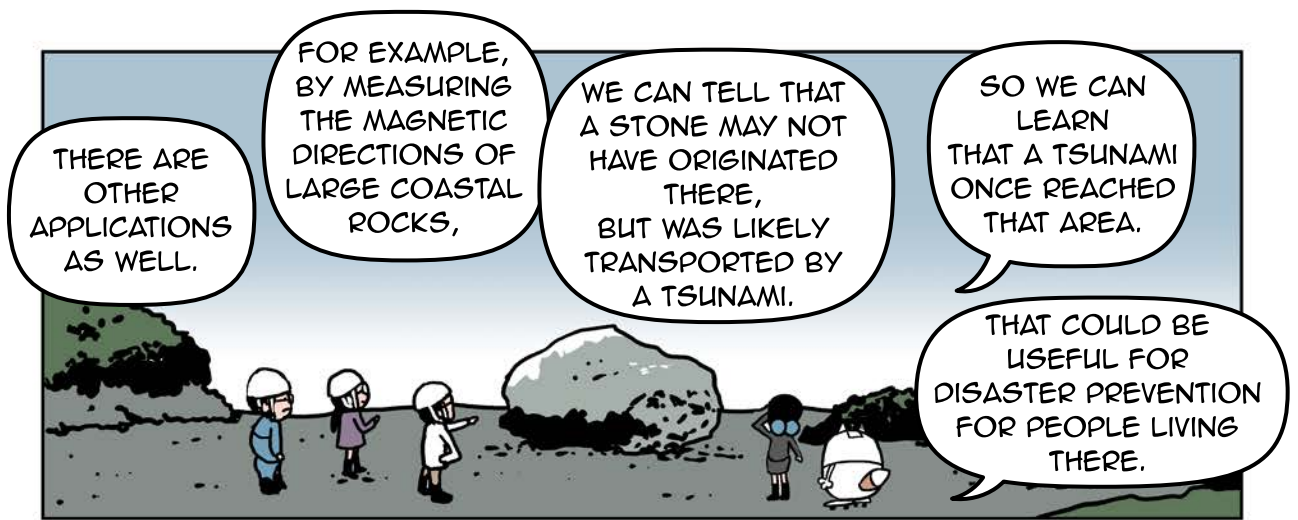
BY STUDYING  
ROCKS AND  
SEDIMENTS,

WE CAN TRACE  
GEOMAGNETIC CHANGES  
FURTHER BACK IN  
TIME DEEPENING OUR  
UNDERSTANDING OF  
HOW EARTH'S CORE  
GENERATES THE  
MAGNETIC FIELD,

AND  
HOW CONTINENTS  
HAVE MOVED  
OVER LONG  
PERIODS OF TIME.

IN ADDITION,  
BY STUDYING THE  
MAGNETIC SIGNALS  
RECORDED IN LAYERS OF  
ROCK AND SEDIMENTS,  
WE CAN OBTAIN CLUES  
ABOUT WHEN THOSE  
LAYERS WERE FORMED.

SO IT'S NOT  
JUST ABOUT  
ARCHAEOLOGY—  
IT HELPS US  
UNDERSTAND  
THE EARTH ITSELF!



BESIDES  
ARCHAEOMAGNETIC DATING,  
RADIOCARBON DATING  
(CARBON-14 DATING)  
IS ALSO COMMONLY  
USED TO DETERMINE  
A SAMPLE'S AGE.

RADIOCARBON DATING  
IS A METHOD  
THAT DETERMINES AGE BY USING  
THE FACT THAT CARBON-14, WHICH  
LIVING ORGANISMS SUCH AS WOOD,  
CHARCOAL, BONES, AND SHELLS  
TAKE IN WHILE THEY ARE ALIVE,  
GRADUALLY DECREASES  
AFTER DEATH.

YOU CAN READ  
A COMIC CALLED  
"WHAT IS  
CARBON-14?!"  
CHECK IT OUT!

**Dr. MASAYO MINAMI**

Professor,  
Office for the Promotion of Transdisciplinary  
Network / Division for Chronological Research,  
ISEE, Nagoya University.

ARCHAEOMAGNETIC  
DATING ESTIMATES AGE  
BY ANALYZING  
THE DIRECTION AND  
INTENSITY  
OF MAGNETIZATION  
RECORDED IN FIRED  
MATERIALS  
SUCH AS KILNS AND  
POTTERY,  
AS WELL AS  
ROCKS.

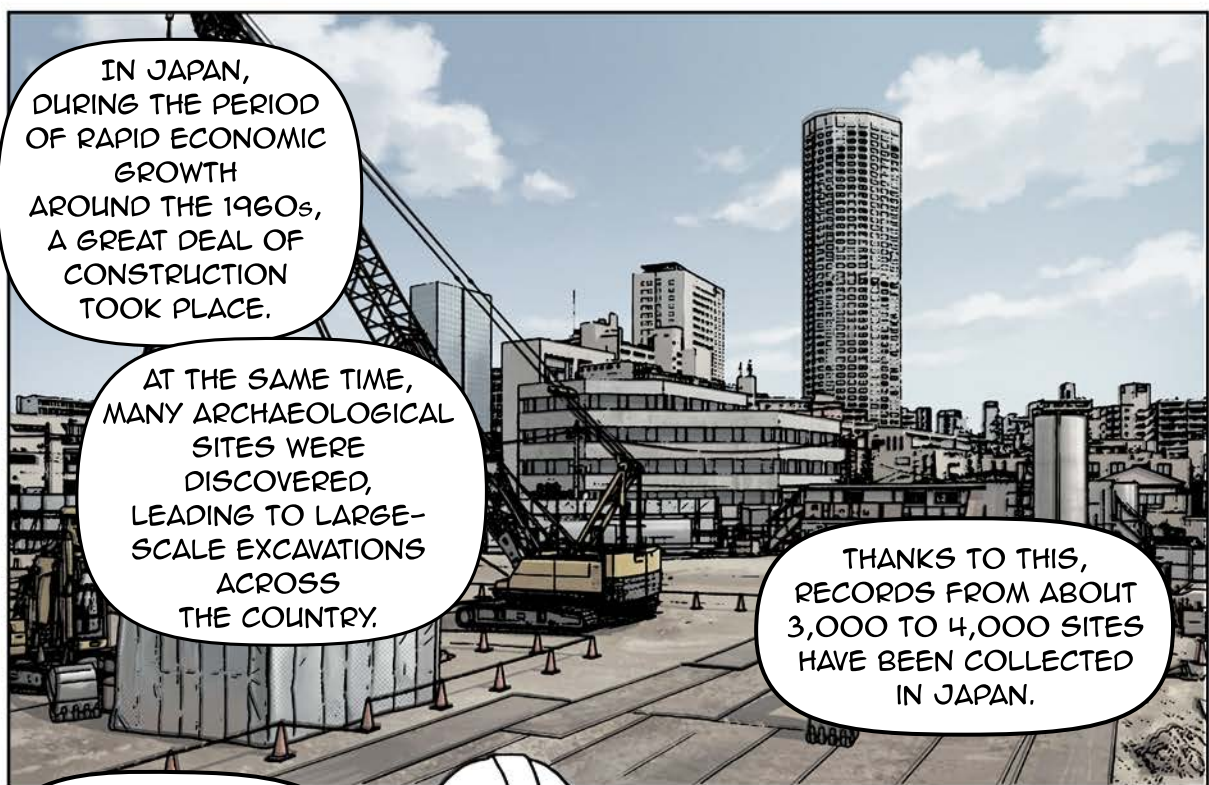
DOES THE MATERIAL  
CONTAIN CARBON?  
OR DOES IT  
CARRY MAGNETIC  
INFORMATION?

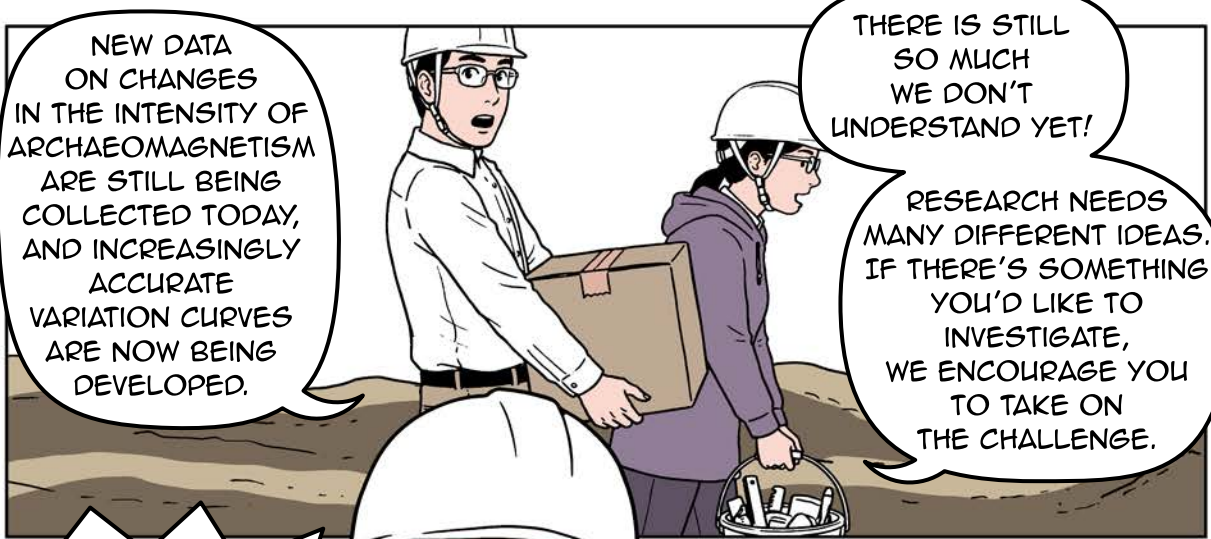
IF ONE METHOD  
DOESN'T WORK,  
WE USE THE OTHER.  
BY COMPLEMENTING  
EACH OTHER,  
THESE METHODS  
HELP US DETERMINE  
MORE  
RELIABLE AGES.

THIS WAY,  
WE CAN TEST  
WHETHER ARCHAEOLOGICAL  
HYPOTHESES AND EVEN  
HISTORICAL ACCOUNTS  
FOUND IN ANCIENT  
DOCUMENTS  
ARE ACTUALLY TRUE.

WRITTEN RECORDS  
AND  
DATING OBJECTS,  
HUH...!

PEOPLE  
INVESTIGATE  
THE PAST  
IN MANY  
DIFFERENT  
WAYS.





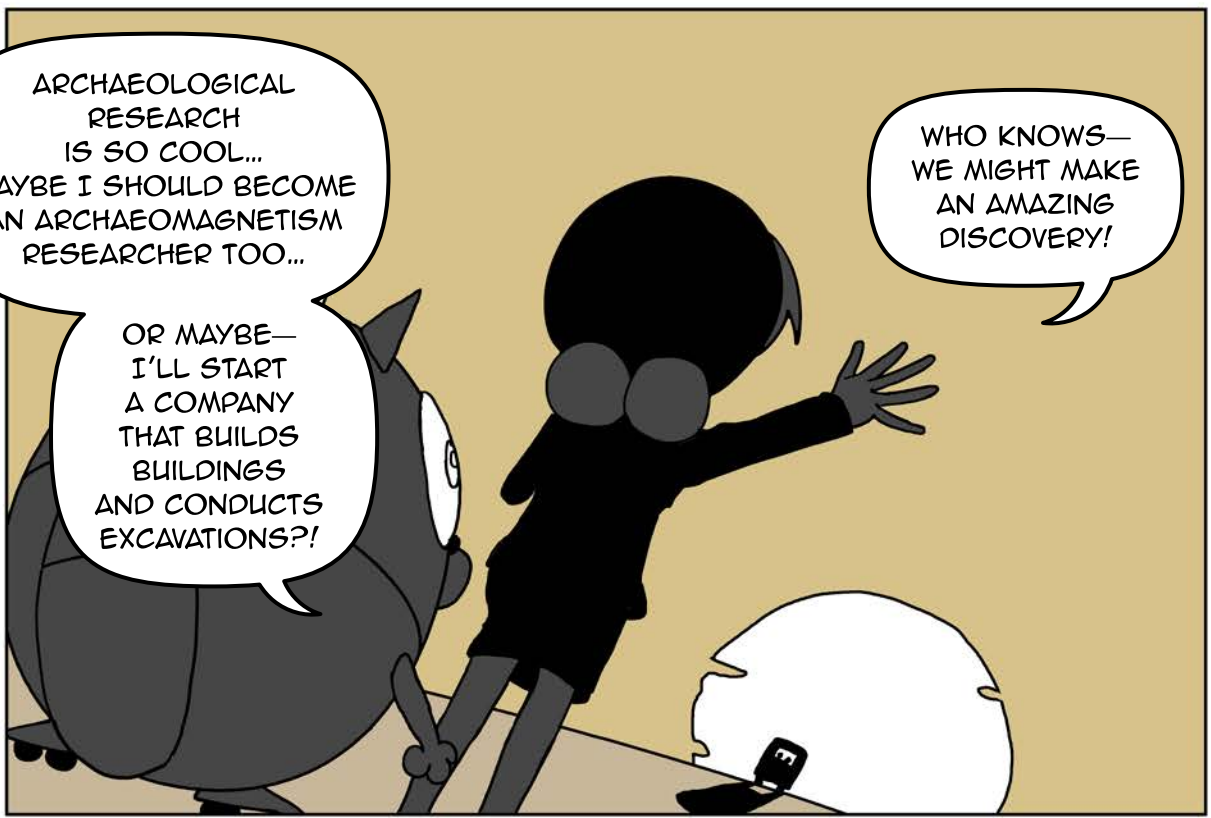
NEW DATA  
ON CHANGES  
IN THE INTENSITY OF  
ARCHAEOMAGNETISM  
ARE STILL BEING  
COLLECTED TODAY,  
AND INCREASINGLY  
ACCURATE  
VARIATION CURVES  
ARE NOW BEING  
DEVELOPED.

THERE IS STILL  
SO MUCH  
WE DON'T  
UNDERSTAND YET!

RESEARCH NEEDS  
MANY DIFFERENT IDEAS.  
IF THERE'S SOMETHING  
YOU'D LIKE TO  
INVESTIGATE,  
WE ENCOURAGE YOU  
TO TAKE ON  
THE CHALLENGE.

ALL RIGHT—  
SAMPLE  
COLLECTION  
COMPLETE!!

LET'S HEAD BACK  
TO THE LAB  
AND START THE  
MEASUREMENTS!



ARCHAEOLOGICAL  
RESEARCH  
IS SO COOL...  
MAYBE I SHOULD BECOME  
AN ARCHAEOMAGNETISM  
RESEARCHER TOO...

OR MAYBE—  
I'LL START  
A COMPANY  
THAT BUILDS  
BUILDINGS  
AND CONDUCTS  
EXCAVATIONS?!

WHO KNOWS—  
WE MIGHT MAKE  
AN AMAZING  
DISCOVERY!

# What is Archaeomagnetism?!



So archaeomagnetism can tell us when something was made—like its age?



Yeah, you use it for dating things. Got it. I totally get it now!



Dating is just one of the entry points. Archaeomagnetism can also help us infer what actually happened at a site.



Burnt soil and clay products record the Earth's magnetic field at the moment they were heated. Now, what do you think happens if there's another major fire later on?



Wait—So you can tell whether it was fired just once—or fired a second time later?!



Exactly. And that means we can test whether famous historical fires or battles really happened the way they're described.

For example, Sakamoto Castle, built in the late 16th century in Japan, associated with the warlord Akechi Mitsuhide, is said to have been destroyed by a great fire when it fell. But was it really?

When researchers examined roof tiles from the site, they found that the magnetization had changed at around 400 degrees Celsius.



400 degrees, that wouldn't happen under normal conditions. It strongly suggests an intentional, human-caused fire.



So archaeomagnetism can actually check whether historical accounts are true.



That's amazing! What else can it tell us?



Apparently, it can even help answer the question: When did magnets arrive in Japan?



Really? How does that work? I want to know!



We know from eighth-century documents that magnets existed in Japan by the Nara period. But before that, written records are unclear. So instead of texts, we looked at the orientation of buildings.



Wait—how can you tell that from the Earth's magnetic field?!



Yes. The layout of temple complexes changes subtly over time. When we compare their orientations with the geomagnetic declination of each period, some seventh-century temples appear to reflect the magnetic field of their time.



If those orientations were chosen deliberately, it suggests that people already had knowledge of magnetic direction—possibly using magnets.



Even without old documents, the Earth's magnetic field can tell us the truth.  
—If words can't answer it, ask the ground—  
Natural science is so cool!



Exactly. And when we combine methods—like radiocarbon dating and archaeomagnetism—we start to see a much clearer picture of the past.



Archaeomagnetism sounds fascinating. Do you think I could become a researcher too?

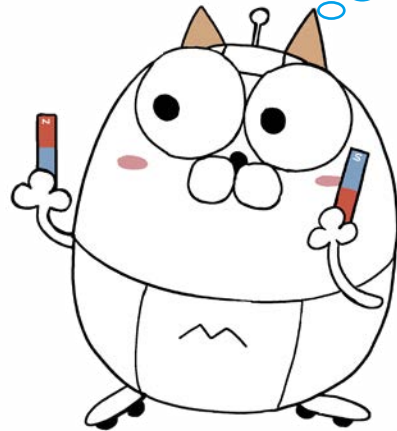


Absolutely. In fact, there aren't many archaeomagnetism researchers. In Japan, only about five or six core research groups are active. Which means many mysteries still remain unresolved.



Heh heh heh... Exactly. Archaeomagnetism is far from a "finished" science. It's a field where new researchers will keep asking new questions—and making new discoveries.

Magnets are something we see all the time, but we didn't know they could help us learn about the past! Now we really want to know more, so maybe we'll try reading a book about the Earth's magnetic field!





The Institute for Space-Earth Environmental Research (ISEE), Nagoya University, studies the Earth, the Sun, and space as an integrated system, promoting interdisciplinary research that bridges space science and Earth science through international collaboration.

<https://www.isee.nagoya-u.ac.jp/>



MEXT Promotion of Development of a Joint Usage/Research System Project: Coalition of Universities for Research Excellence Program (CURE)

## Transdisciplinary Network linking Space-Earth Environmental Science, History, and Archaeology (TranSEHA)

In September 2024, ISEE launched the Transdisciplinary Network linking Space-Earth Environmental Science, History, and Archaeology (TranSEHA) program in collaboration with five partner institutions: the National Museum of Japanese History; the Center for Accelerator Mass Spectrometry, Yamagata University; the Advanced Asian Archaeological Research Center, Kyushu University; the Joint Support-Center for Data Science Research; and the Center for Digital Humanities and Social Sciences, Nagoya University. Centered on four research groups—archaeomagnetic research group, cataclysmic disasters and dating group, solar-terrestrial environmental history group, and interdisciplinary database research and development group—the program aims to establish a new transdisciplinary network integrating space-Earth environmental science, history, and archaeology.

<https://transeha.isee.nagoya-u.ac.jp/en>

### Research Institute of Frontier Science and Technology, Okayama University of Science

By integrating theory and technology, this institute advances cross-disciplinary research to explore new scientific frontiers, aiming to create academic and societal value through research and international collaboration.

<https://ifst.ous.ac.jp/>

### Advanced Asian Archaeological Research Center, Kyushu University.

A research center that leverages Kyushu University's archaeological materials as academic resources, serving as an international interdisciplinary hub for the study and utilization of Asian cultural heritage.

<https://isgs.kyushu-u.ac.jp/~qa3rc/>

### Japanese Archaeomagnetism Database

A searchable database of archaeomagnetic records accumulated in Japan over the past 50+ years, providing directional and intensity data along with past geomagnetic field variations for research and educational use.

<https://mag.ifst.ous.ac.jp/>



## Hayanon

Science manga artist, born in 1975. Graduated from the Department of Physics, Faculty of Science, University of the Ryukyus, with a B.A. (Science). Completed M.A. (Education) in English Education from the Graduate, Graduate School of Education, Chiba University. Her representative works include "GoGo! MIRUBO", "Fantastic R&D", "Learning Earth Science with MIRUBO" (NASA), and "International Science Olympiad Manga" (Japan Science and Technology Agency). She is a representative of Science Manga Studio Co., Ltd., a PR for research business.

## Science Manga Studio, Japan

is a company that produces science communication manga featuring academic research, along with journal cover illustrations, research diagrams, and explanatory visuals. It works across a wide range of disciplines in both the sciences and humanities, and also supports the development of early-career science illustrators through its production work.

<https://www.sciencemanga.com/>

### Illustrators and Designers in the production

Hayanon, Akiba, Ms.Shell, Hakushi Jaco, Omidu and Ikuto, all from Science Manga Studio Co., Ltd.

## What Is...?! Series

This is a research introduction Manga series started in 2002.

You can learn about the study of the Sun and Earth with Sensei, Mirubo, and Mol.



<https://www.isee.nagoya-u.ac.jp/en/outreach.html>

ISEE MIRUBO

Q SEARCH

PDFs are distributed free of charge. In addition to the English version, Japanese and other language versions are also available.