CARBON COMICS 1

CENTER FOR APPLIED ISOTOPE STUDIES

Written by Alice M. W. Hunt & John G. Swogger Illustrated by John G. Swogger

UNLOCKING the PAST!

RADIOCARBON DATING

HOW THE TEAM AT CAIS CAN TELL THIS FRAGMENT OF ANTLER IS OVER 900 YEARS OLD...

WELCOME TO THE CENTER FOR APPLIED ISOTOPE STUDIES (CAIS), AND THE AMAZING WORLD OF RADIOCARBON DATING - WHERE ARCHAEOLOGISTS AND PHYSICISTS USE SCIENCE TO UNLOCK THE PAST! WE'RE GOING TO BE SHOWING YOU HOW THE CARBON INSIDE ANCIENT BONES CAN TELL US HOW OLD SOMETHING IS - EVEN SOMETHING THAT'S BEEN BURIED IN THE EARTH FOR THOUSANDS OF YEARS.

DOING THIS KIND OF SCIENCE TAKES A WHOLE TEAM OF PEOPLE. HERE ARE THE ARCHAEOLOGISTS AND RESEARCH SCIENTISTS AT CAIS WHO MAKE RADIOCARBON DATING POSSIBLE - THEY'RE GOING TO TELL YOU WHAT RADIOCARBON DATING IS USED FOR, HOW IT WORKS AND HOW THEY DO IT.

ALEX

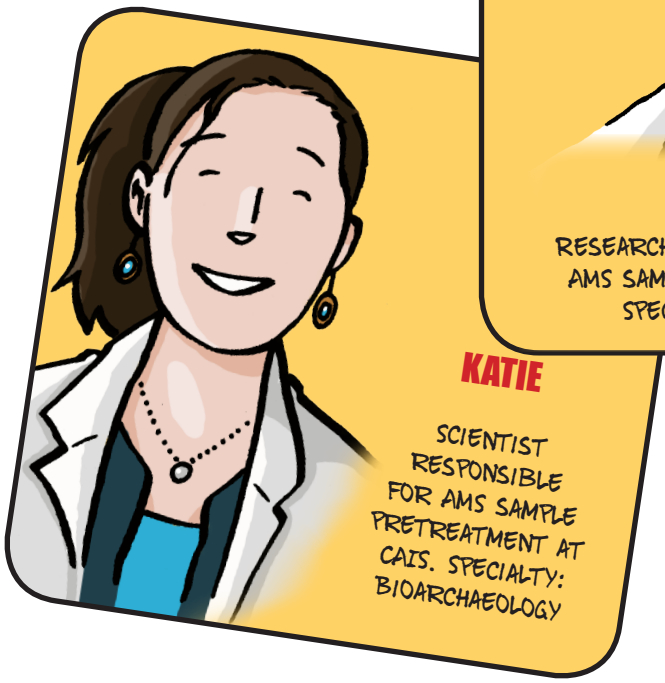
RESEARCH SCIENTIST RESPONSIBLE FOR AMS RADIOCARBON DATING AT CAIS. SPECIALTY: BIOGEOCHEMISTRY

JOSH

GEOARCHAEOLOGIST AND MUSEUM CURATOR IN ALASKA. SPECIALTY: SUBARCTIC AND ARCTIC ARCHAEOLOGY

CARLA

RESEARCH SCIENTIST RESPONSIBLE FOR AMS SAMPLE CARBONIZATION AT CAIS. SPECIALTY: ZOOARCHAEOLOGY



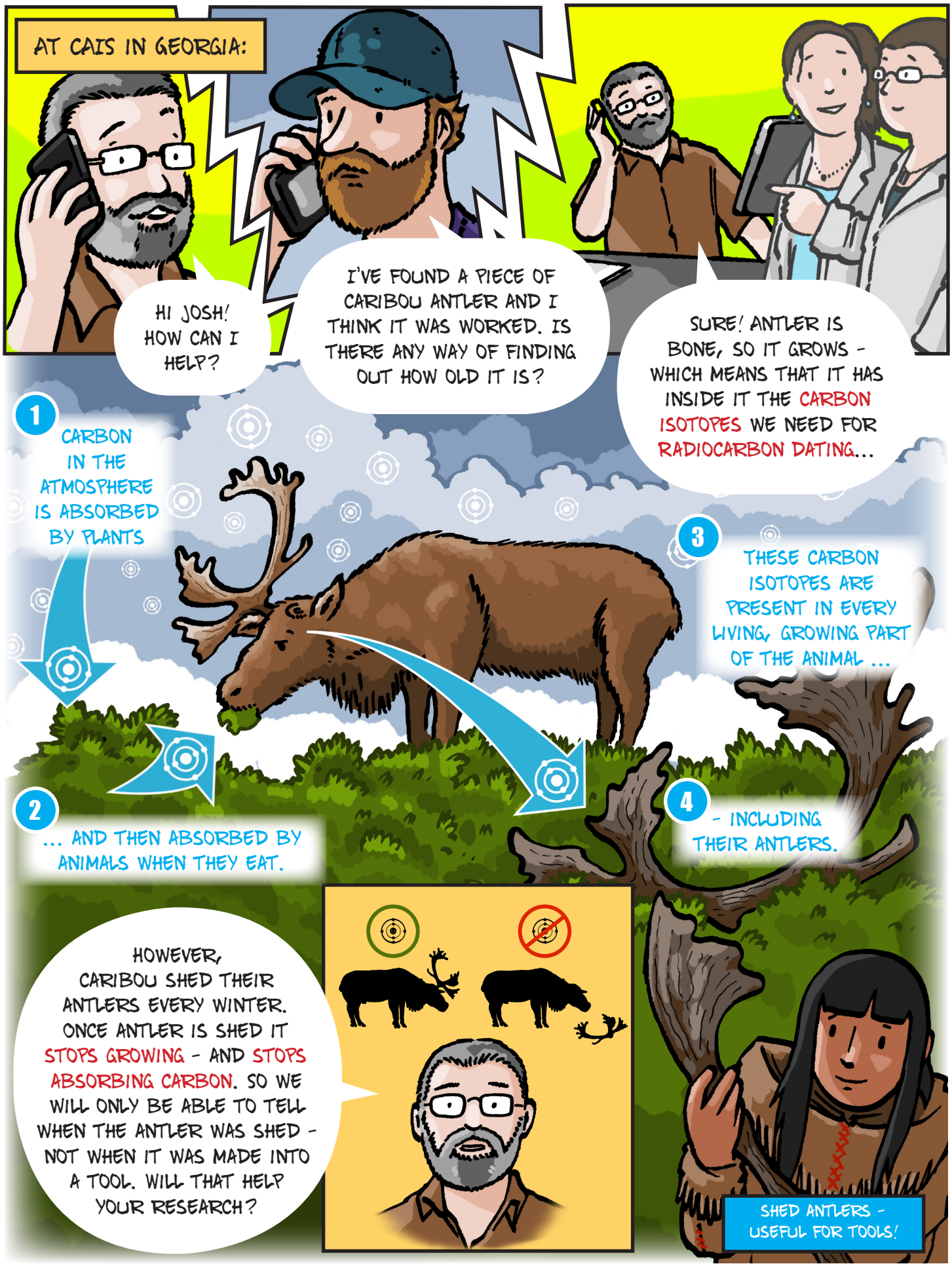
KATIE

SCIENTIST RESPONSIBLE FOR AMS SAMPLE PRETREATMENT AT CAIS. SPECIALTY: BIOARCHAEOLOGY

RAVI

RESEARCH SCIENTIST RESPONSIBLE FOR OPERATION OF THE AMS FACILITY AT CAIS. SPECIALTY: NUCLEAR PHYSICS.


OUR STORY BEGINS A LONG WAY AWAY, AT AN ARCHAEOLOGICAL EXCAVATION IN ALASKA...
HEY, JOSH! COME AND LOOK AT THIS!
HMM. IT'S A PIECE OF CARIBOU ANTLER...
WHERE JOSH AND HIS TEAM HAVE JUST MADE A VERY INTERESTING DISCOVERY...
IT LOOKS LIKE IT WAS ORIGINALLY WORKED...
WORKED: MADE INTO A TOOL OR OTHER OBJECT
ARCHAEOLOGISTS LIKE JOSH ARE LOOKING FOR EVIDENCE TO DETERMINE WHEN OUR ANCESTORS LIVED AND HUNTED IN THIS PART OF THE WORLD.
IT WOULD BE REALLY USEFUL TO OUR RESEARCH TO KNOW EXACTLY HOW OLD THIS PIECE OF ANTLER IS...
I'LL PHONE ALEX AT CAIS...


AT CAIS IN GEORGIA:
HI JOSH! HOW CAN I HELP?
I'VE FOUND A PIECE OF CARIBOU ANTLER AND I THINK IT WAS WORKED. IS THERE ANY WAY OF FINDING OUT HOW OLD IT IS?
SURE! ANTLER IS BONE, SO IT GROWS - WHICH MEANS THAT IT HAS INSIDE IT THE CARBON ISOTOPES WE NEED FOR RADIOCARBON DATING...
1
CARBON IN THE ATMOSPHERE IS ABSORBED BY PLANTS
2
... AND THEN ABSORBED BY ANIMALS WHEN THEY EAT.
3
THESE CARBON ISOTOPES ARE PRESENT IN EVERY LIVING, GROWING PART OF THE ANIMAL ...
4
- INCLUDING THEIR ANTLERS.
HOWEVER, CARIBOU SHED THEIR ANTLERS EVERY WINTER. ONCE ANTLER IS SHED IT STOPS GROWING - AND STOPS ABSORBING CARBON. SO WE WILL ONLY BE ABLE TO TELL WHEN THE ANTLER WAS SHED - NOT WHEN IT WAS MADE INTO A TOOL. WILL THAT HELP YOUR RESEARCH?
SHED ANTLERS - USEFUL FOR TOOLS!


YES, IT WILL. EVEN KNOWING WHEN THE ANTLER WAS COLLECTED WILL BE USEFUL.
I'LL NEED TO SEE HOW WELL THE ANTLER IS PRESERVED - THAT WILL TELL ME WHETHER THERE'S ENOUGH COLLAGEN IN THE BONE FOR US TO USE.
COLLAGEN MAKES UP ALMOST A QUARTER OF OUR BODIES. THE BONE, CARTILAGE, TENDONS AND SKIN OF ALL ANIMALS ARE MADE OF COLLAGEN. ANTLER IS ALSO MADE FROM COLLAGEN.
1
COLLAGEN FOUND INSIDE THE ANTLER...
2
... IS FORMED OF LOTS OF TINY FIBERS...
3
... WHICH ARE MADE OF STRANDS CALLED FIBRILS...
4
... WHICH ARE FORMED OF TWISTED COLLAGEN MOLECULES. IT'S THE CARBON INSIDE THESE MOLECULES THAT CAN BE USED FOR RADIOCARBON DATING.
GREAT! I'LL SEND YOU THE PIECE OF ANTLER!
THE ANTLER IS CAREFULLY PACKAGED AND SENT TO CAIS.


AT CAIS, KATIE'S JOB IS TO GET THE COLLAGEN OUT OF THE ANTLER.
HERE'S THE ANTLER, KATIE!
BEFORE I DO ANYTHING ELSE, I HAVE TO CLEAN THE ANTLER - IT'S STILL GOT SOIL ON IT FROM THE EXCAVATION!
KATIE CUTS A SMALL PIECE OF THE ANTLER TO USE AS A SAMPLE.
IT IS SOAKED IN COLD HYDROCHLORIC ACID...
... WHICH DISSOLVES THE UNWANTED MINERAL PART OF THE ANTLER.
THE SAMPLE IS RINSED IN SODIUM HYDROXIDE...
... AND HYDROCHLORIC ACID TO REMOVE CONTAMINANTS.
THEN IT IS RINSED IN DE-IONIZED WATER...
... HEATED TO 80 DEGREES CENTIGRADE...
...FOR 8-12 HOURS...
AND FINALLY, PUT THROUGH A FIBERGLASS FILTER AND DRIED.
AND WHAT'S LEFT ARE COLLAGEN FIBERS - ALL READY FOR THE NEXT STEP!

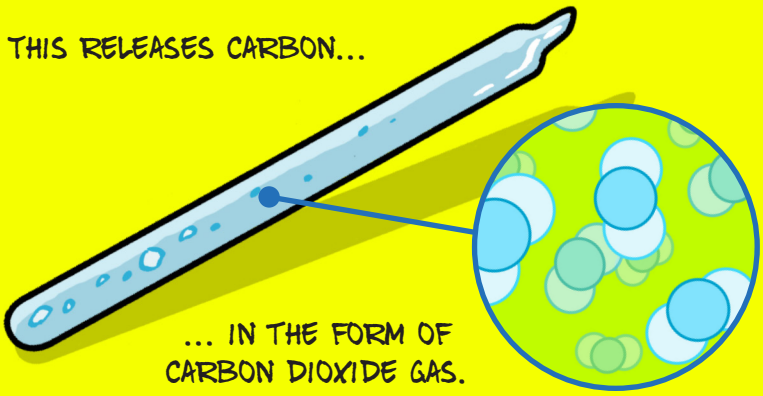
NEXT, CARLA'S JOB IS TO GET THE CARBON OUT OF THE COLLAGEN..

TO DO THAT, WE FIRST WE TURN IT INTO A GAS, THEN WE TURN IT BACK INTO A SOLID!

I SEAL THE COLLAGEN FIBERS AND SOME COPPER OXIDE INSIDE THIS PYREX AMPOULE.

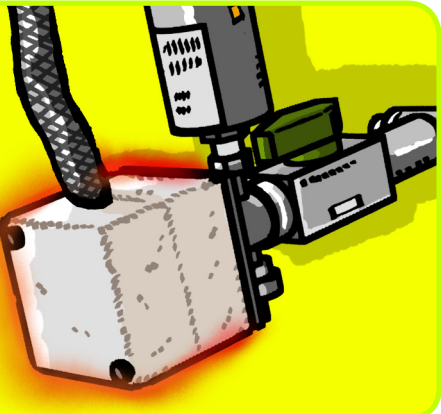
THE AMPOULE IS HEATED TO 575 DEGREES CENTIGRADE.

THIS RELEASES CARBON...

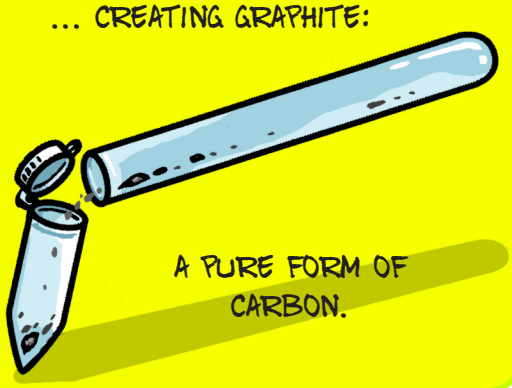


... IN THE FORM OF CARBON DIOXIDE GAS.

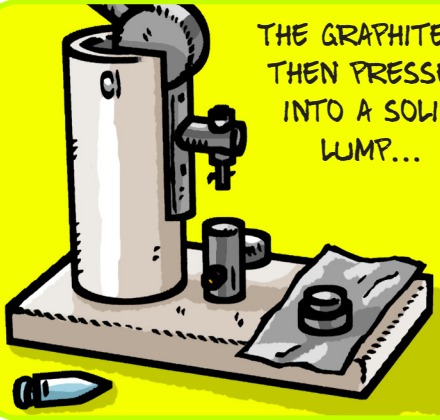
TO REMOVE THE OXYGEN AND GET PURE CARBON, HYDROGEN GAS AND IRON ARE ADDED AND HEATED AGAIN, TO 580 DEGREES CENTIGRADE...



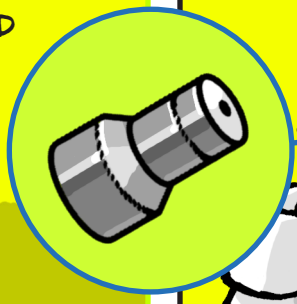
... CREATING GRAPHITE:

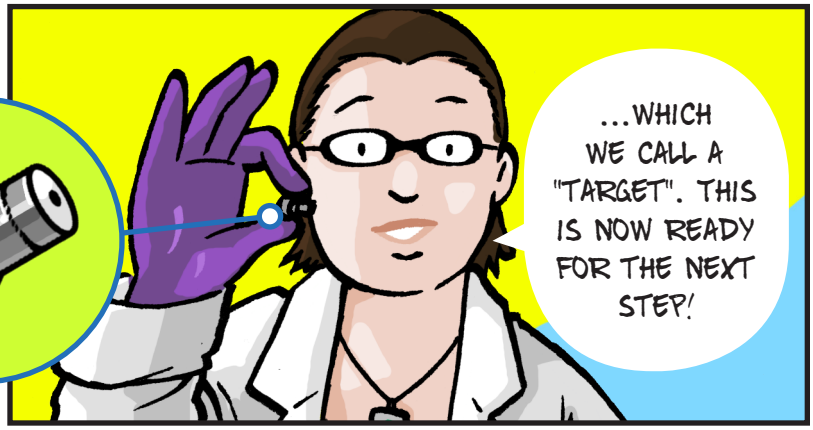


A PURE FORM OF CARBON.

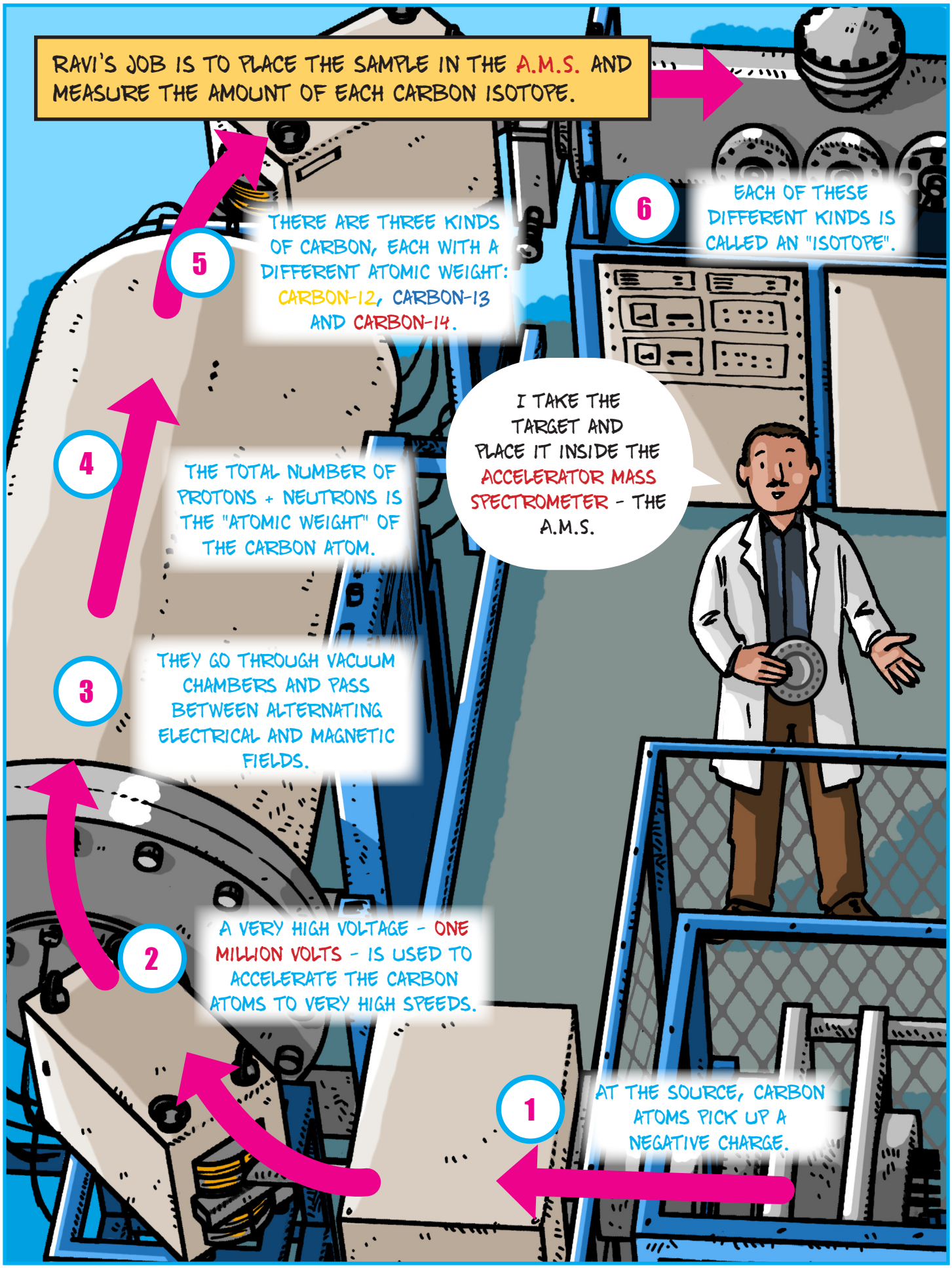


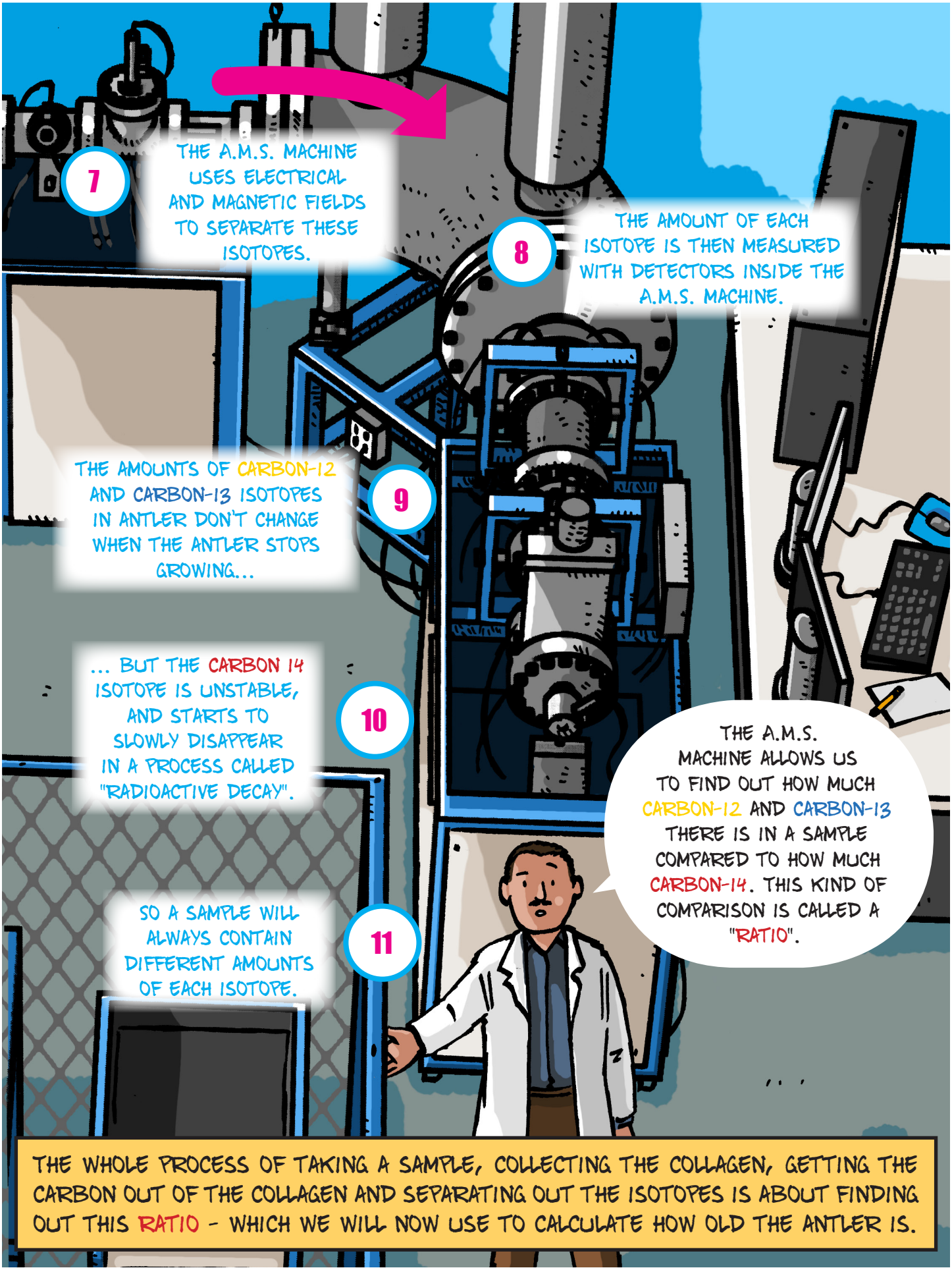
THE GRAPHITE IS THEN PRESSED INTO A SOLID LUMP...





...WHICH WE CALL A "TARGET". THIS IS NOW READY FOR THE NEXT STEP!


RAVI'S JOB IS TO PLACE THE SAMPLE IN THE A.M.S. AND MEASURE THE AMOUNT OF EACH CARBON ISOTOPE.
1
AT THE SOURCE, CARBON ATOMS PICK UP A NEGATIVE CHARGE.
2
A VERY HIGH VOLTAGE - ONE MILLION VOLTS - IS USED TO ACCELERATE THE CARBON ATOMS TO VERY HIGH SPEEDS.
3
THEY GO THROUGH VACUUM CHAMBERS AND PASS BETWEEN ALTERNATING ELECTRICAL AND MAGNETIC FIELDS.
4
THE TOTAL NUMBER OF PROTONS + NEUTRONS IS THE "ATOMIC WEIGHT" OF THE CARBON ATOM.
5
THERE ARE THREE KINDS OF CARBON, EACH WITH A DIFFERENT ATOMIC WEIGHT: CARBON-12, CARBON-13 AND CARBON-14.
6
EACH OF THESE DIFFERENT KINDS IS CALLED AN "ISOTOPE".
I TAKE THE TARGET AND PLACE IT INSIDE THE ACCELERATOR MASS SPECTROMETER - THE A.M.S.


7
THE A.M.S. MACHINE USES ELECTRICAL AND MAGNETIC FIELDS TO SEPARATE THESE ISOTOPES.
8
THE AMOUNT OF EACH ISOTOPE IS THEN MEASURED WITH DETECTORS INSIDE THE A.M.S. MACHINE.
THE AMOUNTS OF CARBON-12 AND CARBON-13 ISOTOPES IN ANTLER DON'T CHANGE WHEN THE ANTLER STOPS GROWING...
9
... BUT THE CARBON 14 ISOTOPE IS UNSTABLE, AND STARTS TO SLOWLY DISAPPEAR IN A PROCESS CALLED "RADIOACTIVE DECAY".
10
SO A SAMPLE WILL ALWAYS CONTAIN DIFFERENT AMOUNTS OF EACH ISOTOPE.
11
THE A.M.S. MACHINE ALLOWS US TO FIND OUT HOW MUCH CARBON-12 AND CARBON-13 THERE IS IN A SAMPLE COMPARED TO HOW MUCH CARBON-14. THIS KIND OF COMPARISON IS CALLED A "RATIO".
THE WHOLE PROCESS OF TAKING A SAMPLE, COLLECTING THE COLLAGEN, GETTING THE CARBON OUT OF THE COLLAGEN AND SEPARATING OUT THE ISOTOPES IS ABOUT FINDING OUT THIS RATIO - WHICH WE WILL NOW USE TO CALCULATE HOW OLD THE ANTLER IS.

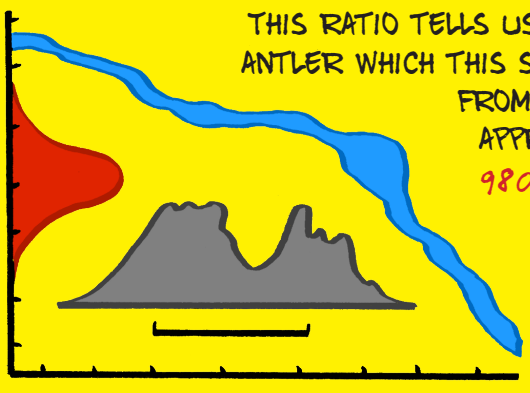
I'VE SENT YOU THE A.M.S. DATA FROM THE ANTLER SAMPLE, ALEX.

THANKS, RAVI. I'LL START PROCESSING THIS DATA AND CALIBRATING THE RADIOCARBON DATE USING THE CARBON 13 - CARBON 14 RATIO.

THE ANTLER STARTED OUT WITH THE SAME PROPORTION OF CARBON-13 AND CARBON-14 AS THERE WAS IN THE ATMOSPHERE...

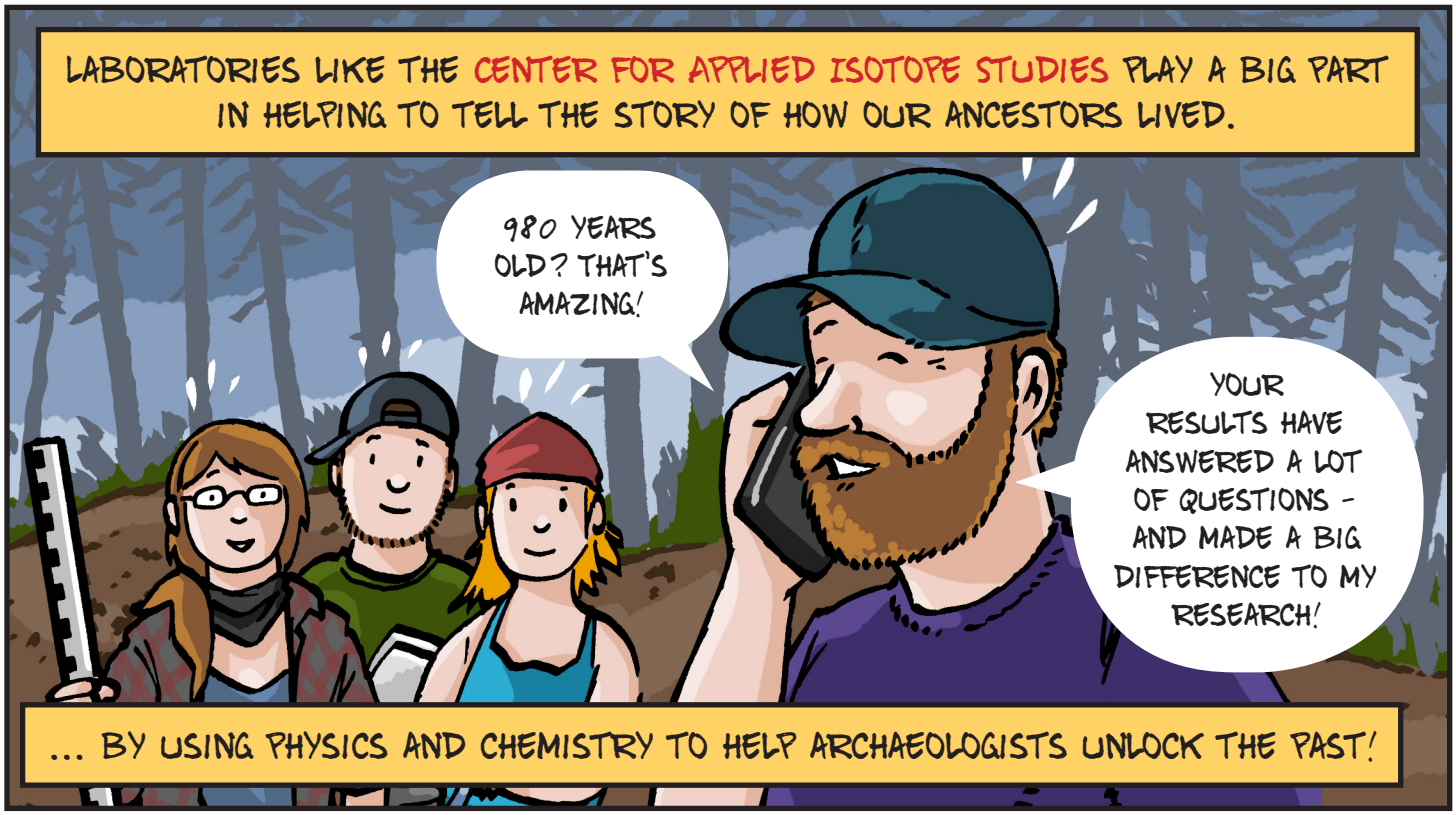
OVER TIME, THE AMOUNT OF CARBON-13 DIDN'T CHANGE, BUT RADIOACTIVE DECAY MEANT THAT THE AMOUNT OF CARBON-14 GOT LESS...

THE BIGGER THE DIFFERENCE BETWEEN THE AMOUNT OF CARBON-13 AND CARBON-14, THE OLDER THE ANTLER IS.



THIS RATIO TELLS US THAT THE ANTLER WHICH THIS SAMPLE CAME FROM WAS SHED APPROXIMATELY 980 YEARS AGO.

I'LL PHONE JOSH AND TELL HIM THE RESULT!



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Carbon Comics No. 1 - *Unlocking The Past: Radiocarbon Dating*

Written by Alice M. W. Hunt and John G. Swogger
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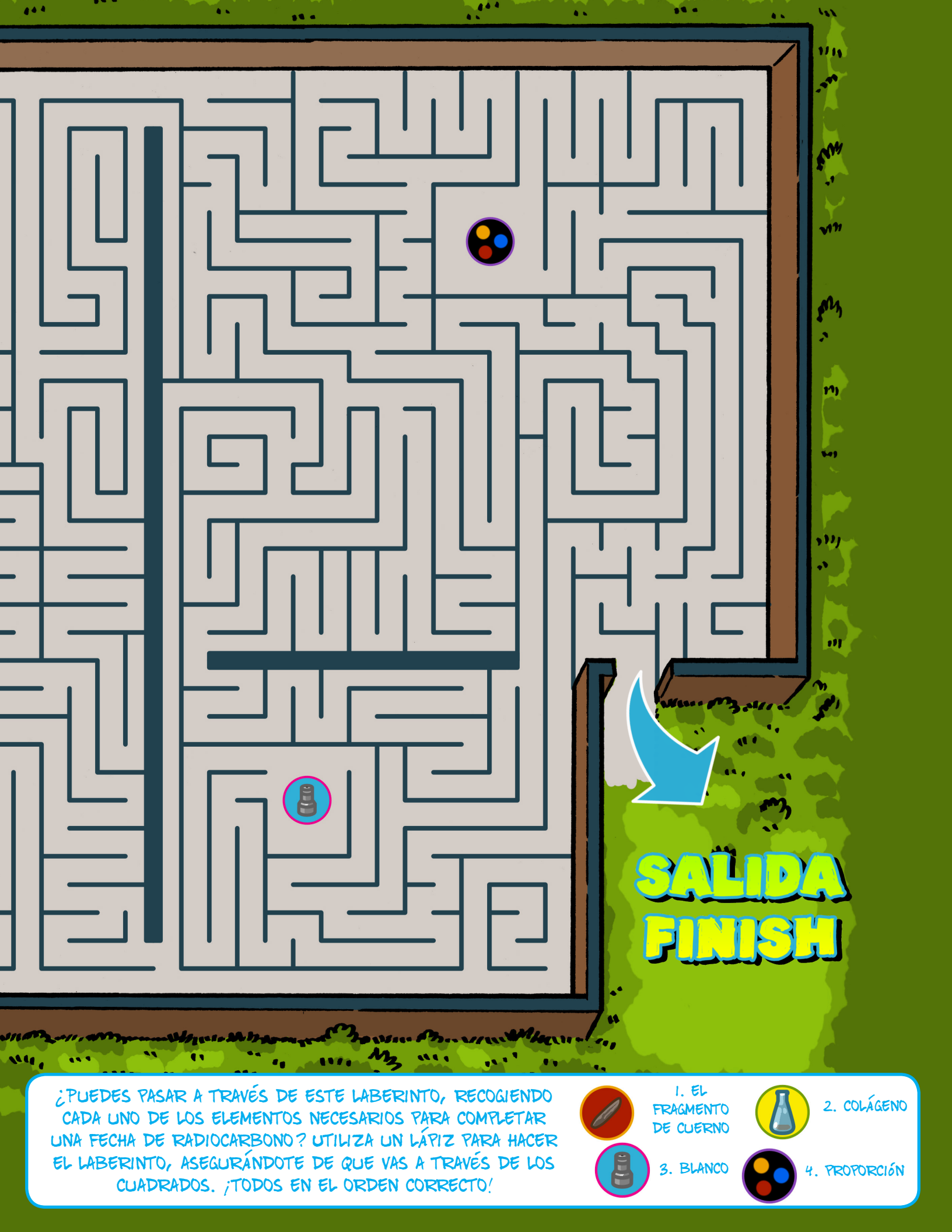
Translated by Maria Jose Rivera Araya
Additional Translation by Bjorn Evans

THE RADIOCARBON MAZE!

CAN YOU GET THROUGH THIS MAZE, PICKING UP EACH OF THE ITEMS NEEDED TO COMPLETE A RADIOCARBON DATE? USE A PENCIL TO DO THE MAZE, MAKING SURE YOU GO THROUGH THE FOLLOWING SQUARES IN THE RIGHT ORDER:

1. ANTLER FRAGMENT
2. COLLAGEN SAMPLE
3. TARGET
4. RATIO



¿PUEDES PASAR A TRAVÉS DE ESTE LABERINTO, RECOGIENDO CADA UNO DE LOS ELEMENTOS NECESARIOS PARA COMPLETAR UNA FECHA DE RADIOCARBONO? UTILIZA UN LÁPIZ PARA HACER EL LABERINTO, ASEGURÁNDOTE DE QUE VAS A TRAVÉS DE LOS CUADRADOS. ¡TODOS EN EL ORDEN CORRECTO!

1. EL FRAGMENTO DE CUERNO
2. COLÁGENO
3. BLANCO
4. PROPORCIÓN