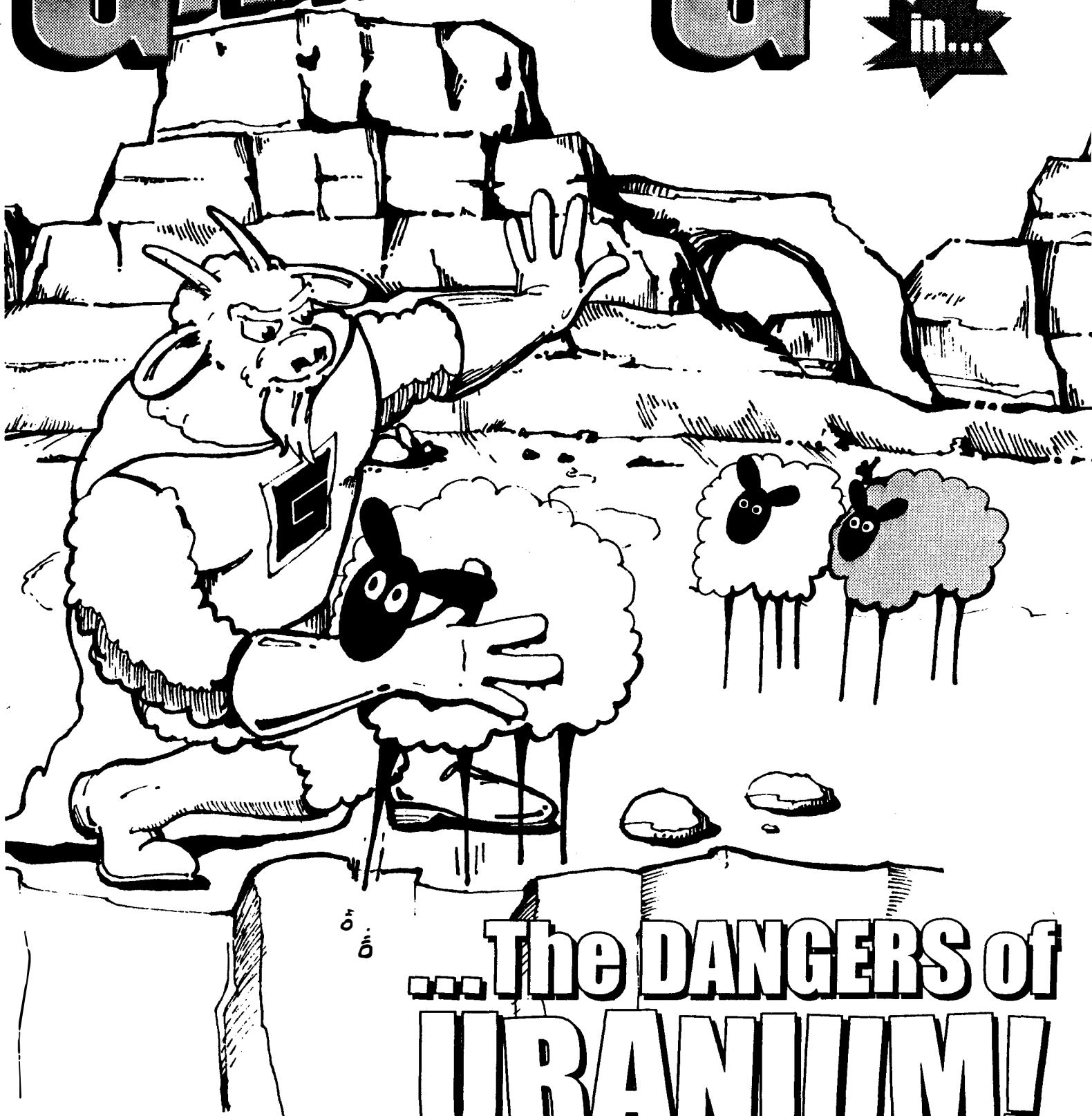
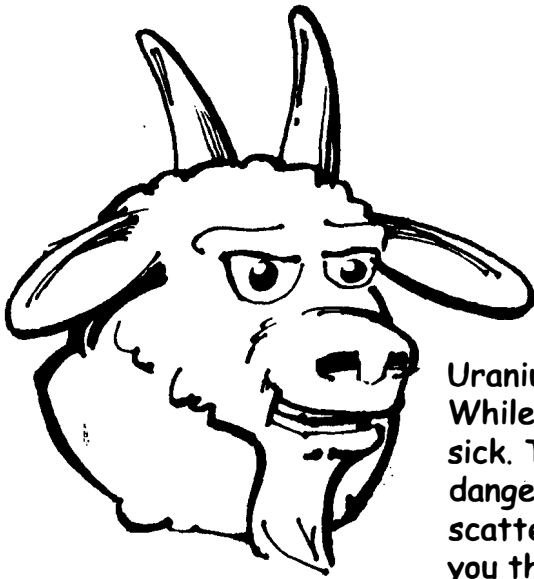


# GAMMA GOAT



...The DANGERS of  
**URANIUM!**



Dear Student, Parent, or Teacher,

Uranium is a natural element that occurs in the earth's crust. While uranium is natural, exposure to uranium can make you sick. This comic book is designed to teach you about the dangers of abandoned uranium mines. Old abandoned mines are scattered across the Navajo Nation. This comic book shows you the physical hazards of old mines and explains the danger of radiation exposure. By learning the safety tips given by Rad Rabbit and Gamma Goat, you will know what to do if you come upon an old abandoned uranium mine.

Some of the words you read may be new to you. If there is a word you don't understand in the text, look it up in the glossary. All underlined words in the text are defined in the glossary at the back of the comic book. The last few pages of the comic book are filled with fun activities that help you remember important information about radiation and abandoned uranium mines.

Please share what you have learned after reading this comic book with others-especially those you know who spend time around old mine sites! Remember my motto:

BE SAFE AND STAY AWAY!

Yours Truly,

*Gamma Goat*

## Gamma Goat in Dangers of Uranium

By Bonnie Robinson Lipscomb  
Illustrations by Jay Robinson

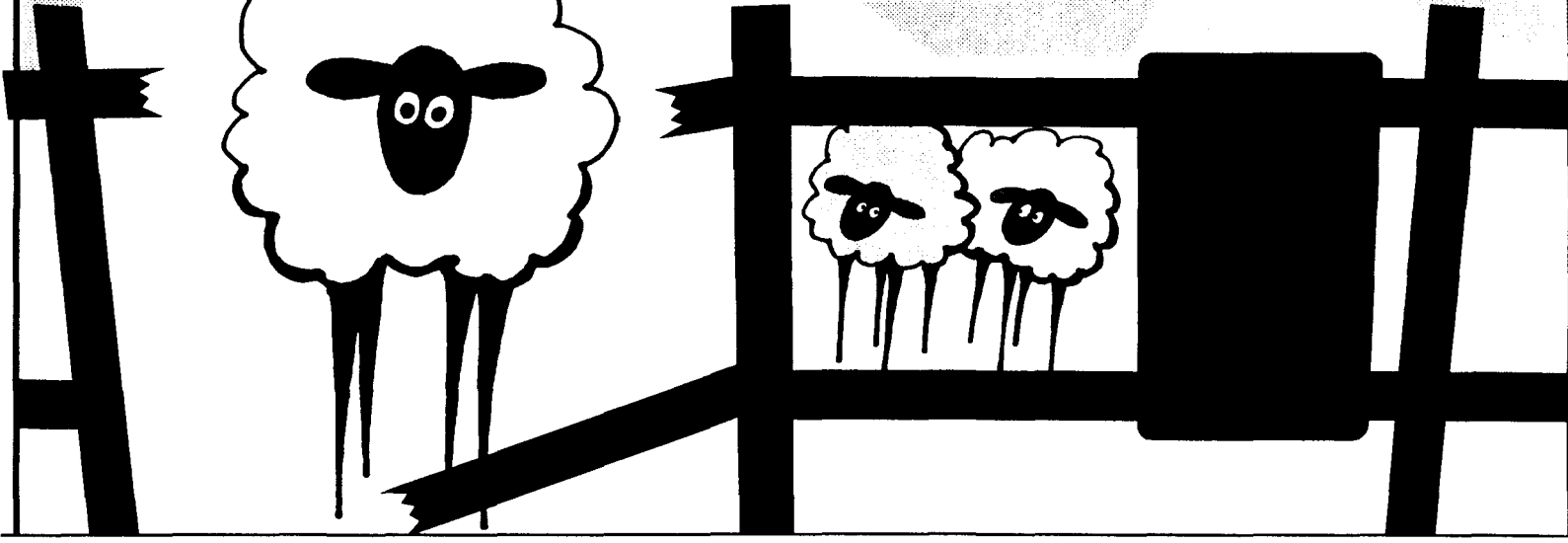
©Bonnie Robinson Lipscomb, 1999  
second edition October, 1999

For more information about uranium and abandoned uranium mines on the Navajo Nation, please contact the Navajo EPA office located in Window Rock, or the US EPA, Region 9, San Francisco, California. For information about this comic book, or to receive additional copies, please contact Bonnie Robinson Lipscomb, 910 Virginia Street, Vallejo, CA. 94590 (707) 554-8281 e-mail: [bonnie@uin.net](mailto:bonnie@uin.net).

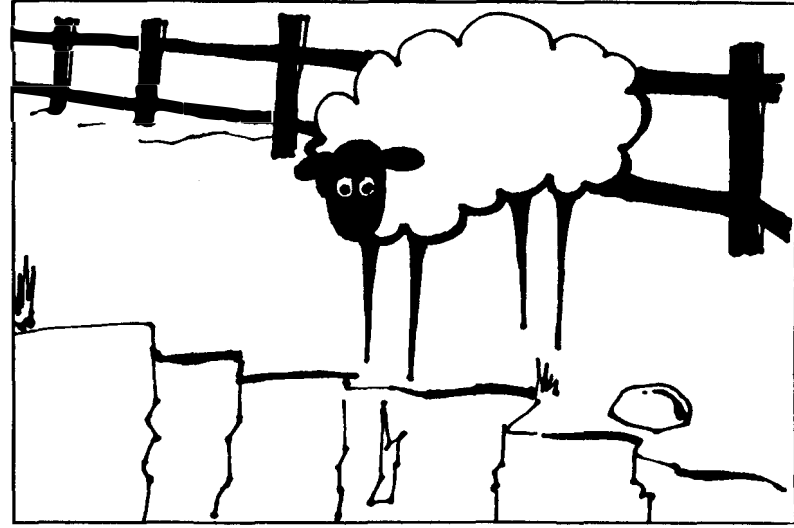
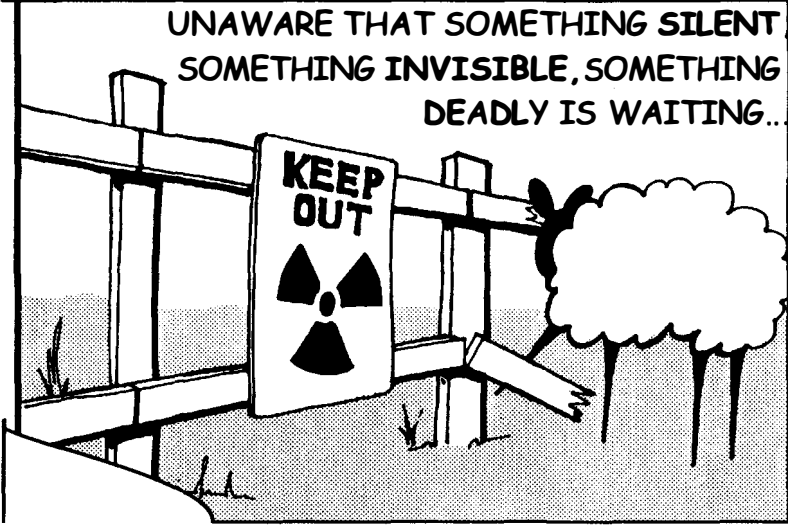
### Acknowledgements

This comic book was funded through a NNEMS fellowship awarded by the US EPA, Region 9, San Francisco. This project would not have been possible without the patience, guidance, and multiple reviews of my grant manager, Patti Collins, and the tireless efforts of my brother Jay, who brought Gamma to life through his illustrations. Many thanks to Loren Setlow, EPA Region 3, for his helpful editorial comments; David C. Peshlakai, from the Cameron Chapter House; Irene Silentman and Eddie Tso from the Dine Culture and Language Office for their useful insights; Bill Chenowith, Vicki Rosen, Professor Paul Mohai at the University of Michigan School of Natural Resources and Environment, and the many students at United Indian Nations and the American Indian Charter School in Oakland, California. Thanks also to my husband Scott for his patience and support.

SOMEWHERE ON THE NAVAJO NATION,  
SOMEONE IS WANDERING TOWARD **DANGER!**



UNAWARE THAT SOMETHING SILENT  
SOMETHING INVISIBLE, SOMETHING  
DEADLY IS WAITING..



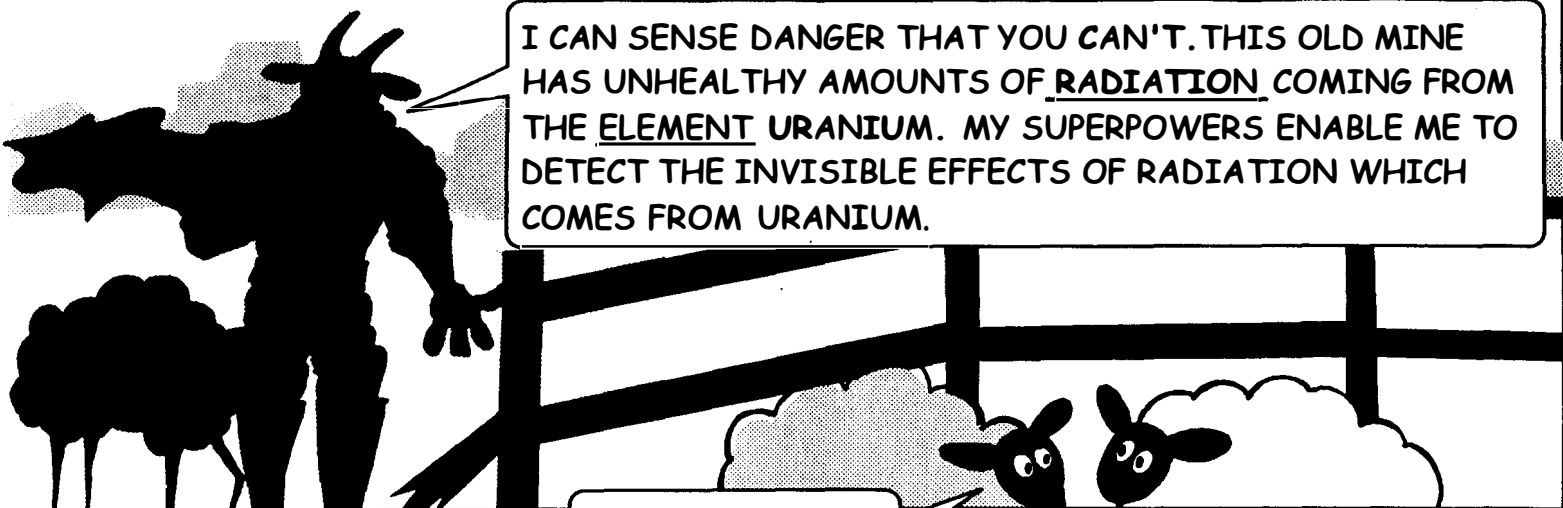
SUDDENLY, OUT OF THE SKY...

**STOP!!**



DON'T GET ANY  
CLOSER. THIS OPEN  
PIT IS ACTUALLY  
AN OLD ABANDONED  
URANIUM MINE.






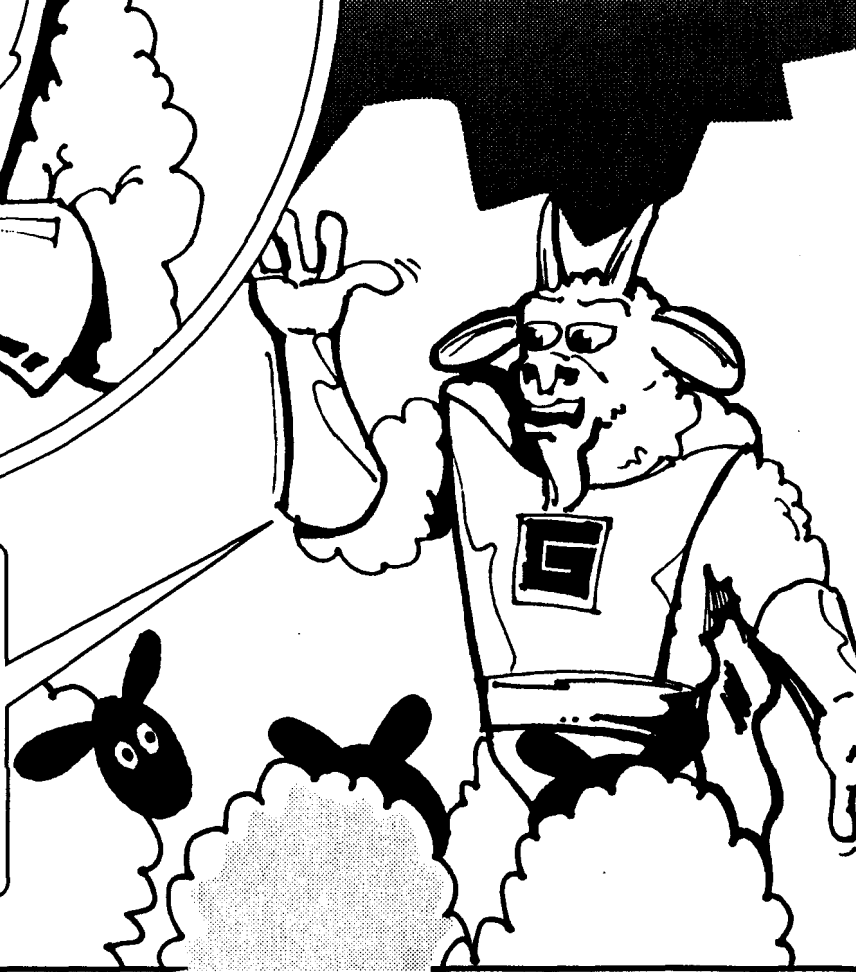
I CAN SENSE DANGER THAT YOU CAN'T. THIS OLD MINE HAS UNHEALTHY AMOUNTS OF RADIATION COMING FROM THE ELEMENT URANIUM. MY SUPERPOWERS ENABLE ME TO DETECT THE INVISIBLE EFFECTS OF RADIATION WHICH COMES FROM URANIUM.



HEY! IT'S **GAMMA GOAT!**

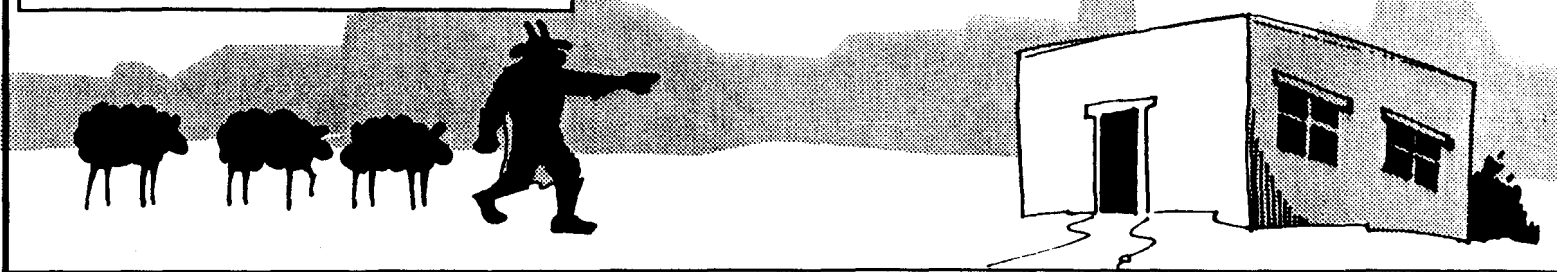


THAT'S RIGHT. I'M NAMED GAMMA AFTER THE MOST POWERFUL FORM OF RADIATION GIVEN OFF BY URANIUM, GAMMA RAYS. I KNOW HOW TO STAY AWAY FROM AREAS WHERE RADIATION MAY HARM ME, AND I'M HERE TO TEACH YOU, YOUR FRIENDS, AND FAMILY HOW TO BE SAFE, TOO.



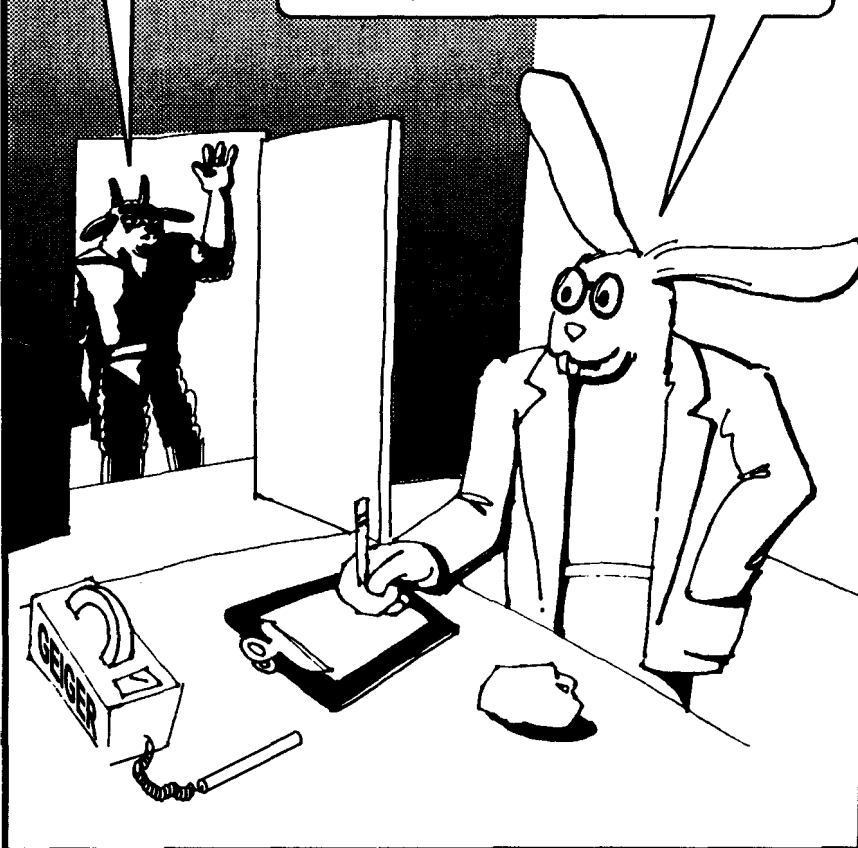
I'D LIKE YOU TO MEET A FRIEND OF MINE WHO KNOWS A LOT ABOUT URANIUM. LISTEN CAREFULLY. UNDERSTANDING WHY YOU SHOULD STAY AWAY FROM AREAS LIKE THESE COULD SAVE YOUR LIFE.

GAMMA LEADS THEM TO HIS FRIEND'S LABORATORY...



HELLO RAD! I'VE BROUGHT SOME NEW FRIENDS TO MEET YOU. I THOUGHT YOU COULD TELL THEM ABOUT URANIUM.

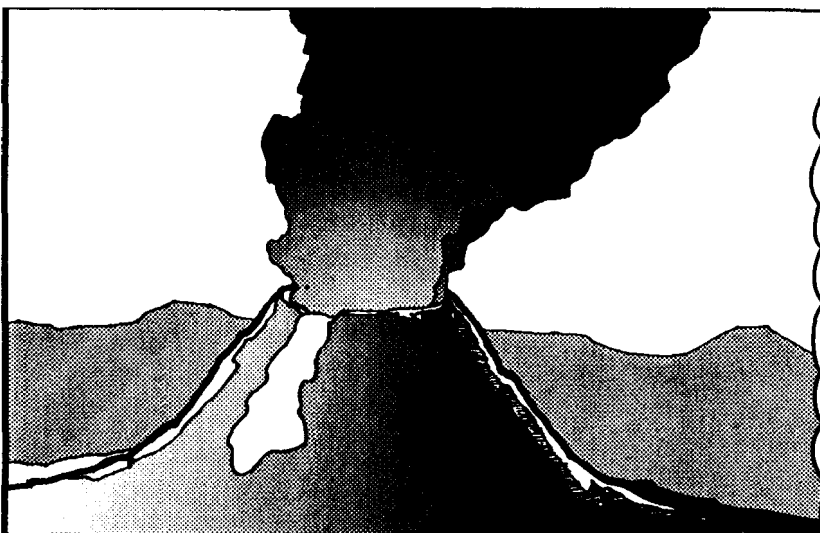
SURE, GAMMA! COME ON IN!



HELLO! MY NAME IS RAD RABBIT. I GREW UP HERE, LIKE YOU, AND NOW I'M A SCIENTIST WORKING TO HELP RECLAIM THE LAND AROUND HERE THAT WAS MINED FOR URANIUM.

YOU ARE PROBABLY WONDERING HOW URANIUM GOT HERE IN THE FIRST PLACE, AND WHY IT IS SO HARMFUL TO OUR HEALTH.

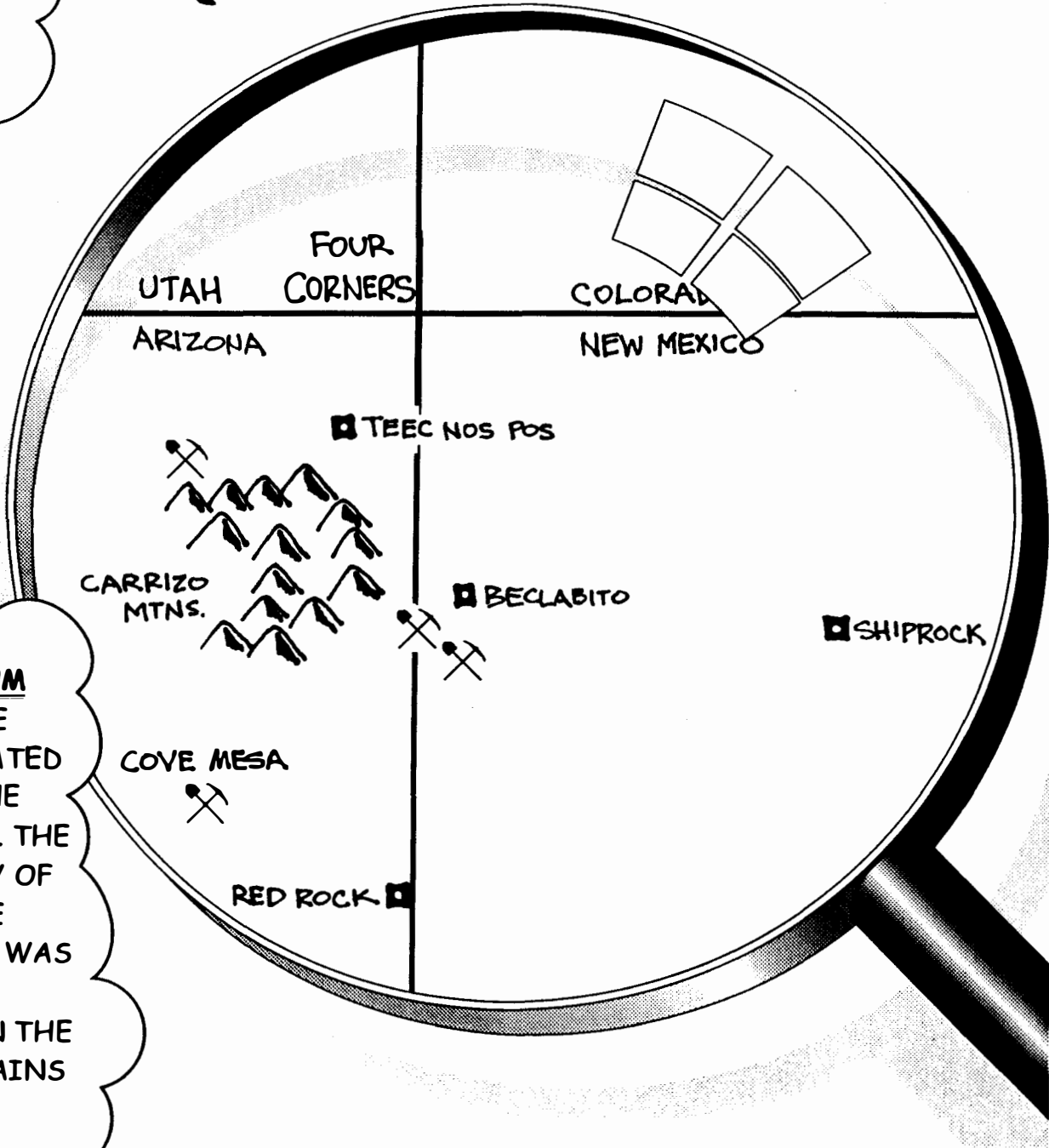
WELL, IT ALL STARTED MILLIONS OF YEARS AGO...



"...LONG AGO, WHEN THE EARTH WAS FORMING, VOLCANIC ACTIVITY AND EARTHQUAKES PUSHED MINERALS, BURIED DEEP WITHIN THE EARTH CLOSER TO THE SURFACE. URANIUM IS ONE OF THE ELEMENTS NOW FOUND NEAR THE SURFACE. URANIUM IS USUALLY FOUND AS YELLOWISH STREAKS OR STAINS IN ROCKS. SOMETIMES IT IS BLACK. PROCESSED URANIUM IS OFTEN CALLED YELLOWCAKE."

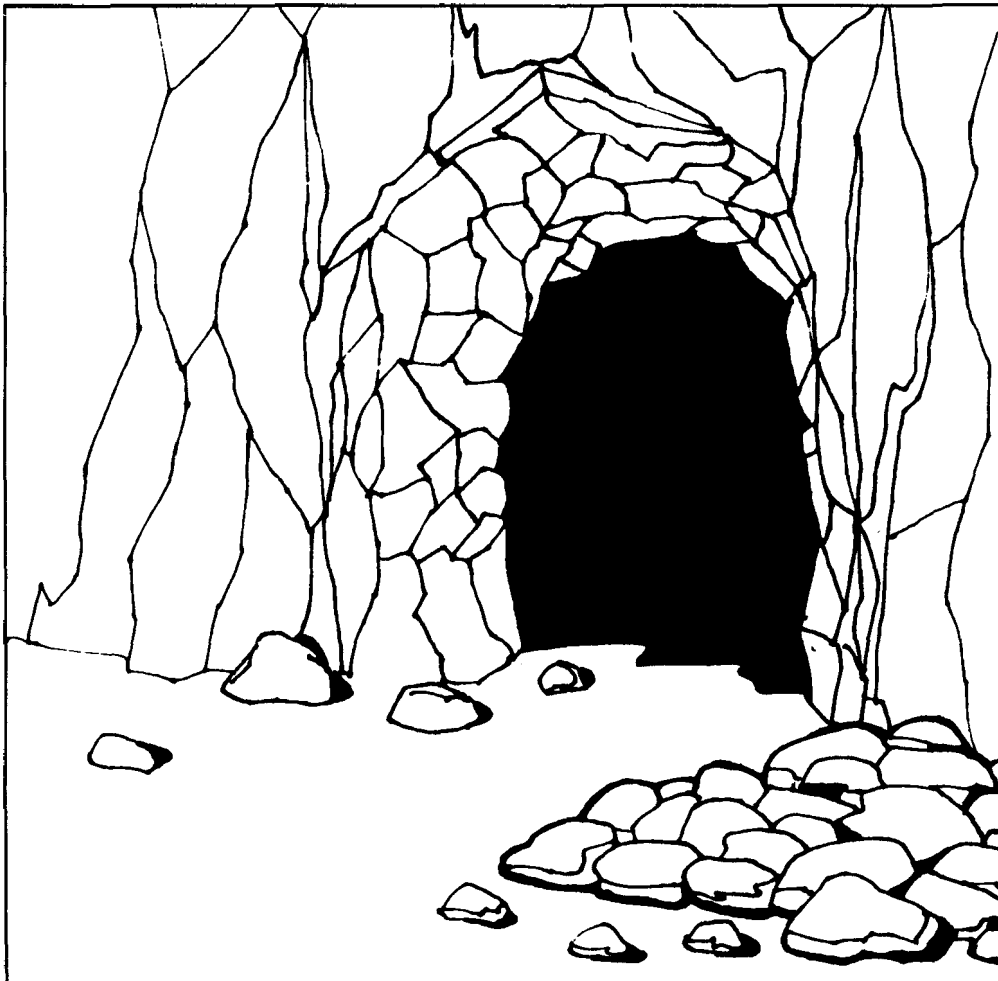


URANIUM IS FOUND ALL OVER THE WORLD. THE STARS ON THE WORLD MAP SHOW SOME OF THE LOCATIONS OF URANIUM WORLDWIDE.



SOME OF THE LARGEST URANIUM RESERVES IN THE WORLD ARE LOCATED PARTIALLY ON THE NAVAJO NATION. THE FIRST DISCOVERY OF URANIUM ON THE NAVAJO NATION WAS NEAR THE FOUR CORNERS AREA IN THE CARRIZO MOUNTAINS IN 1941.

"FROM THE 1940'S THROUGH THE 1970'S, URANIUM WAS MINED ON THE NAVAJO NATION. AFTER IT WAS MINED, IT WAS SENT TO A MILL WHERE IT WAS PROCESSED TO SEPARATE THE URANIUM FROM THE OTHER ELEMENTS FOUND IN THE ROCKS. AFTER THE MILLING PROCESS, THE URANIUM WAS SENT OFF THE RESERVATION TO A DIFFERENT FACILITY TO BE USED IN THE DEVELOPMENT OF NUCLEAR ENERGY AND WEAPONS."

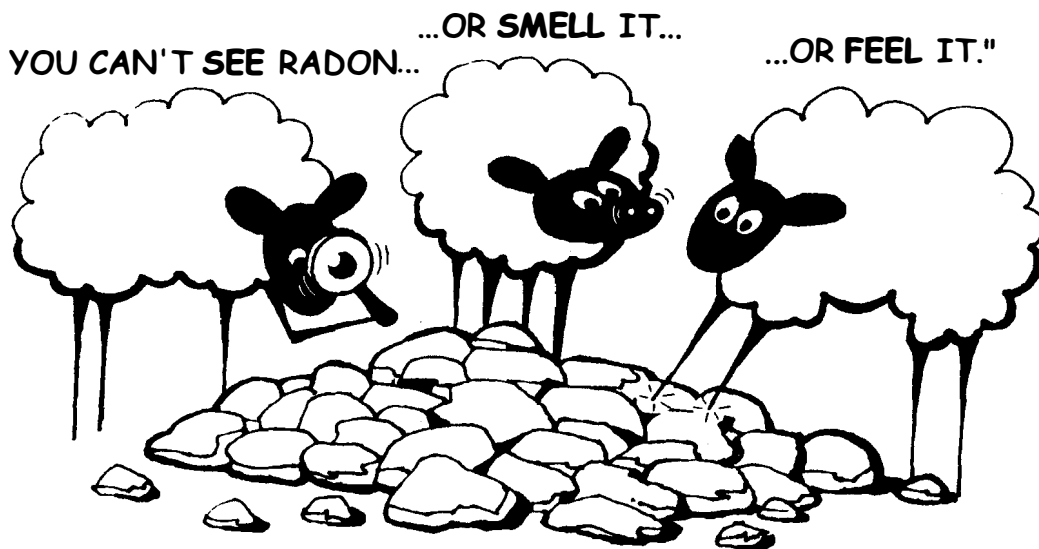


"MANY OF THE ROCKS AROUND OLD MINES (OFTEN CALLED ABANDONED MINES) CONTAIN SMALL AMOUNTS OF URANIUM. OFTEN THESE ROCKS ARE LEFT NEAR THE MINE ENTRANCE IN PILES CALLED DEBRIS PILES."



URANIUM APPEARS AS YELLOW OR BLACK STREAKS OR STAINS. COLOR SOME OF THE ROCKS IN THE DEBRIS PILE YELLOW AND BLACK.

"WHILE THE ROCKS AROUND A URANIUM MINE MAY NOT LOOK DANGEROUS, THEY REALLY COULD HARM YOU. URANIUM GIVES OFF A HARMFUL GAS CALLED RADON.

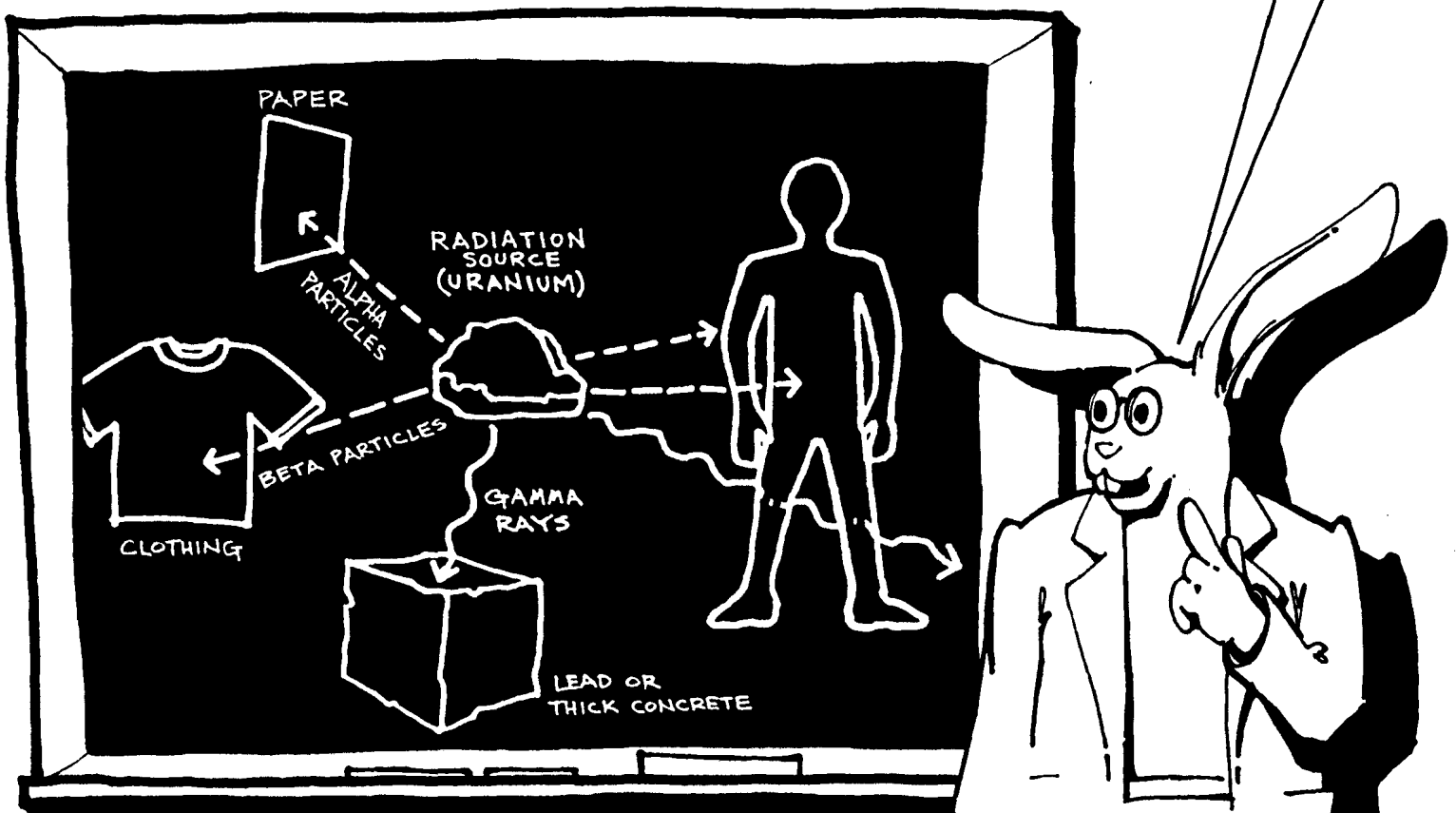


RADON GAS CONTAINS RADIATION IN THE FORM OF ALPHA, BETA, AND GAMMA RAYS. IF YOU SPEND TIME IN OR AROUND A URANIUM MINE, YOU COULD BECOME VERY SICK OR EVEN DIE. EXPOSURE TO RADIATION CAN LEAD TO HAIR LOSS, SKIN RASHES, VOMITING, DIARRHEA, AND CANCER.

ALPHA PARTICLES ARE THE WEAKEST OF THE THREE TYPES OF RADIATION, BUT ONCE THEY ARE INSIDE YOUR BODY, THEY CAN DO THE MOST DAMAGE. ALPHA PARTICLES CAN BE STOPPED BY A PIECE OF PAPER.

BETA PARTICLES ARE STRONGER THAN ALPHA PARTICLES, BUT DO LESS DAMAGE ONCE THEY ARE INSIDE YOUR BODY. BETA PARTICLES CAN GO THROUGH YOUR CLOTHING, BUT ARE STOPPED BY THE FIRST FEW LAYERS OF YOUR SKIN.

GAMMA RAYS ARE THE STRONGEST OF THE THREE, BUT DO THE LEAST DAMAGE INSIDE YOUR BODY. GAMMA RAYS GO RIGHT THROUGH YOUR SKIN, BUT ARE STOPPED BY LEAD OR A THICK SLAB OF CONCRETE.





IF YOU MUST GO PAST AN ABANDONED URANIUM MINE, YOU NEED TO UNDERSTAND HOW TO LIMIT YOUR EXPOSURE TO RADIATION. THERE ARE THREE WAYS TO DO THIS...



TIME

DECREASE *TIME* -- DON'T SPEND ANY TIME AROUND AN OLD MINE SITE. ONE OR TWO MINUTES MAY NOT HARM YOU, BUT DON'T STOP AND PLAY!



DISTANCE

INCREASE *DISTANCE* -- THE FARTHER YOU ARE AWAY FROM THE MINE, THE BETTER. THE LENGTH OF A SCHOOL BUS IS A GOOD DISTANCE, BUT TWO WOULD BE BETTER!

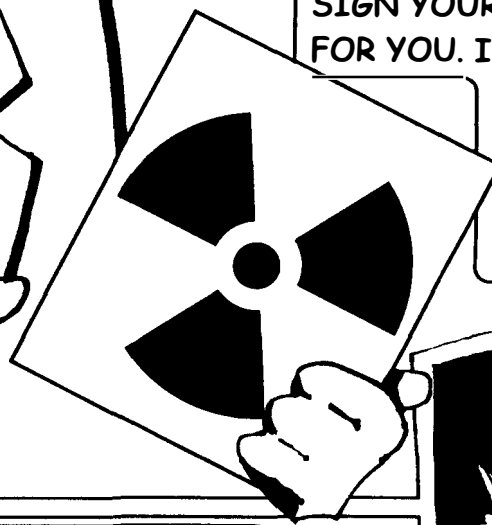
SHIELDING



INCREASE *SHIELDING* -- REMEMBER THAT ALPHA AND BETA PARTICLES CAN'T GO THROUGH YOUR SKIN, BUT GAMMA RAYS CAN GO RIGHT THROUGH YOU. TO PROTECT YOURSELF, WEAR PLENTY OF CLOTHES -- INCLUDING GLOVES.

ALWAYS READ ANY SIGNS YOU SEE POSTED AROUND OLD MINES. IF YOU CAN'T READ A SIGN YOURSELF, HAVE SOMEONE READ IT FOR YOU. IT COULD BE A WARNING SIGN.

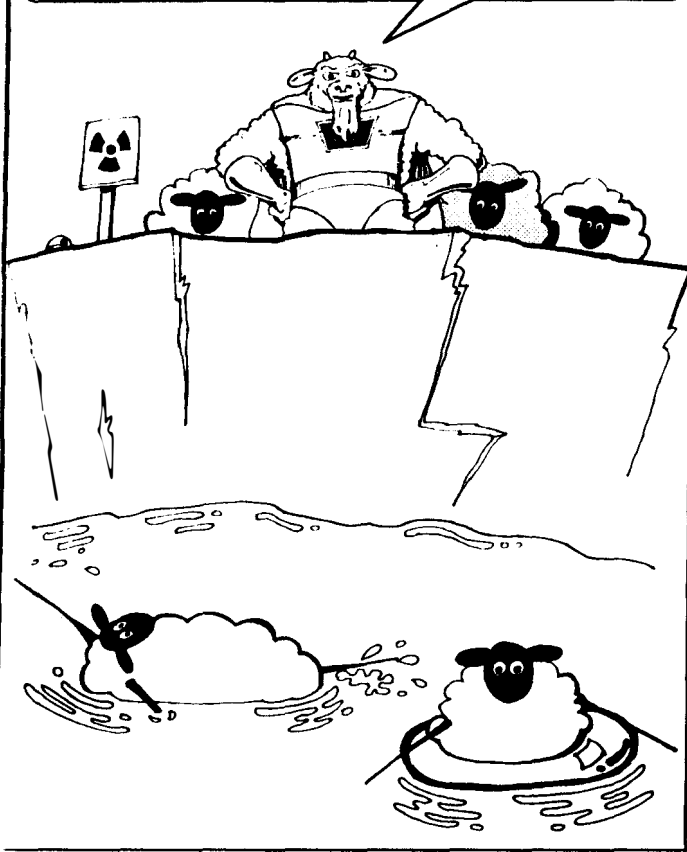
THIS SYMBOL STANDS FOR RADIATION. IF YOU SEE THIS SIGN POSTED ANYWHERE, YOU SHOULD STAY AWAY!



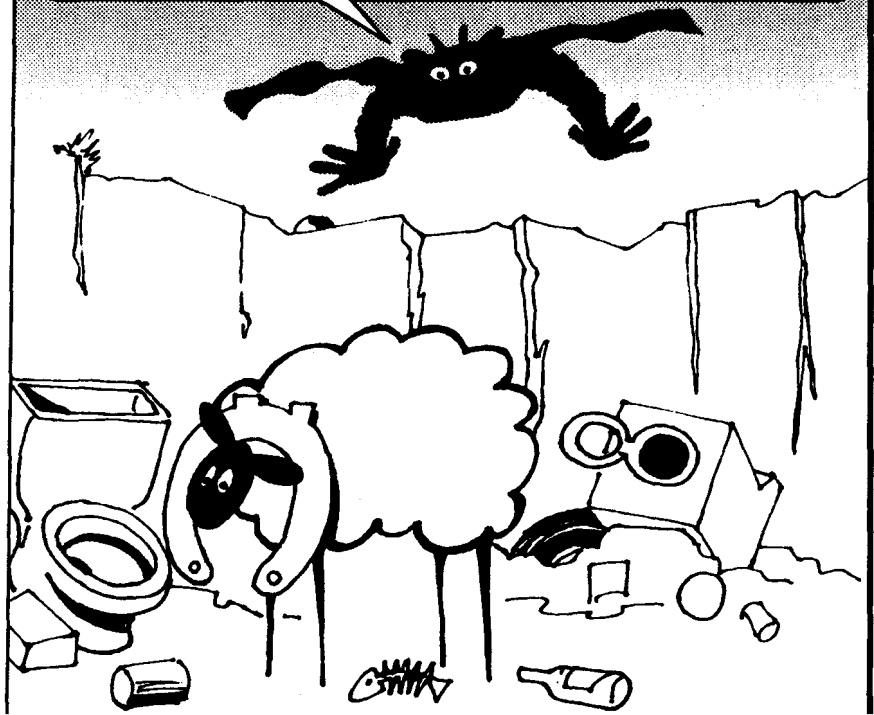
RAD, THANKS FOR SHARING THIS IMPORTANT INFORMATION ABOUT URANIUM AND RADIATION WITH US. NOW THAT WE KNOW WHY AND HOW URANIUM IS DANGEROUS, WE'RE GOING TO GO SEE WHAT OTHER KINDS OF HIDDEN DANGERS WE CAN FIND AROUND ABANDONED MINES.



ABANDONED URANIUM MINES COME IN ALL SHAPES AND SIZES...THIS ABANDONED MINE, CALLED AN OPEN PIT MINE, IS FILLED WITH WATER. IT MAY LOOK LIKE A GOOD PLACE TO SWIM, BUT SWIMMING HERE COULD MAKE YOU VERY SICK!



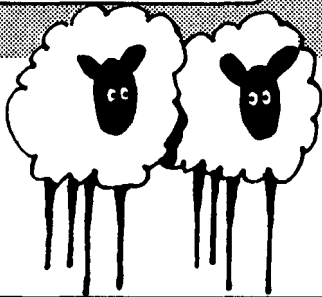
HERE IS ANOTHER OPEN PIT MINE THAT IS BEING USED AS A TRASH DUMP. OVER TIME, RADIATION FROM URANIUM SEEPS INTO OTHER MATERIALS AROUND IT.



PICKING UP ANYTHING FROM A TRASH DUMP IS NOT A GOOD IDEA.



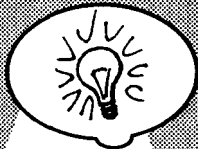
"THIS ABANDONED URANIUM MINE IS CALLED A SHAFT MINE. SOME SHAFT MINES ARE SUPPORTED WITH OLD WOOD AND LOOSE ROCKS."



"PLAYING NEAR MINE OPENINGS IS VERY DANGEROUS-- TAKING A WRONG STEP COULD BE A BIG MISTAKE!"



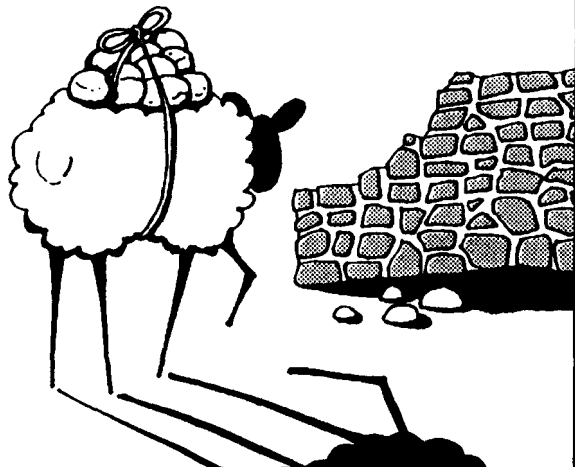
THIS ABANDONED URANIUM MINE HAS A DEBRIS PILE NEXT TO IT. REMEMBER THAT THE ROCKS IN A DEBRIS PILE CONTAIN URANIUM!



LEAVE ALL ROCKS YOU SEE NEAR A MINE SITE ALONE--THEY COULD BE GIVING OFF RADIATION!!



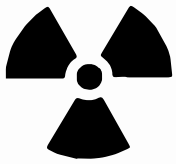
EVEN THOUGH THEY MAY LOOK LIKE GOOD BUILDING MATERIALS, THEY AREN'T.



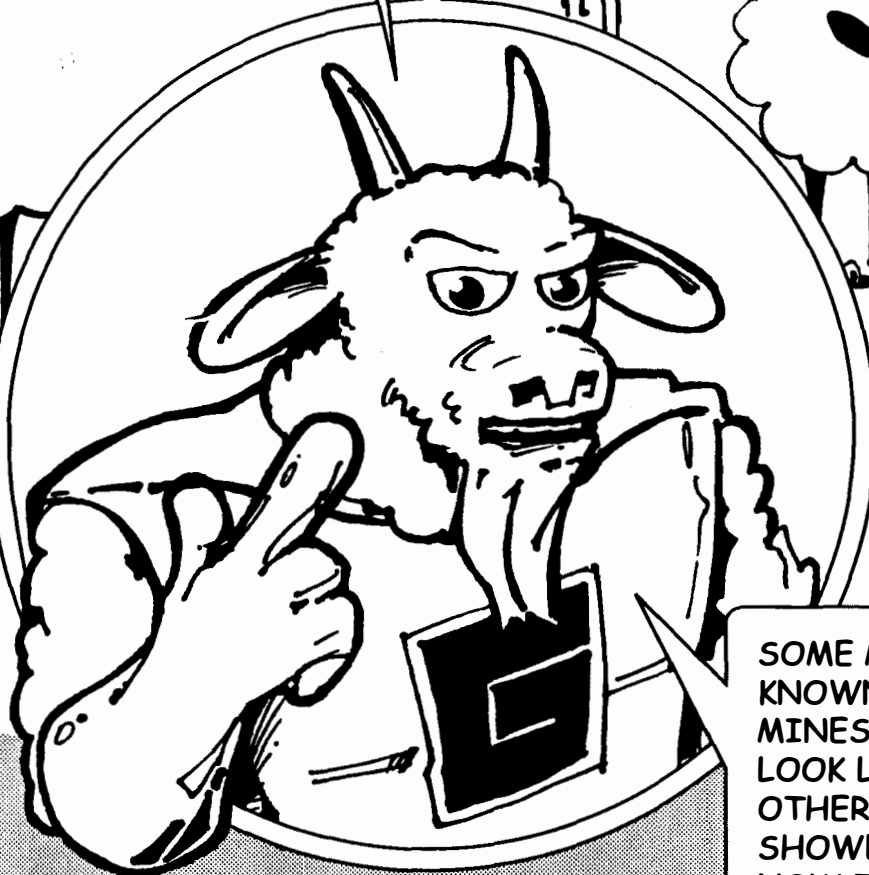
SOME OLD URANIUM MINES ARE SURROUNDED BY FENCES POSTED WITH RADIATION WARNING SIGNS...

...SOMETIMES THESE FENCES AND SIGNS ARE REMOVED, CUT DOWN, OR FALL DOWN ON THEIR OWN. IF YOU APPROACH AN UNMARKED AREA THAT LOOKS LIKE IT COULD BE A MINE SITE, STAY AWAY!

DANGER




DANGER

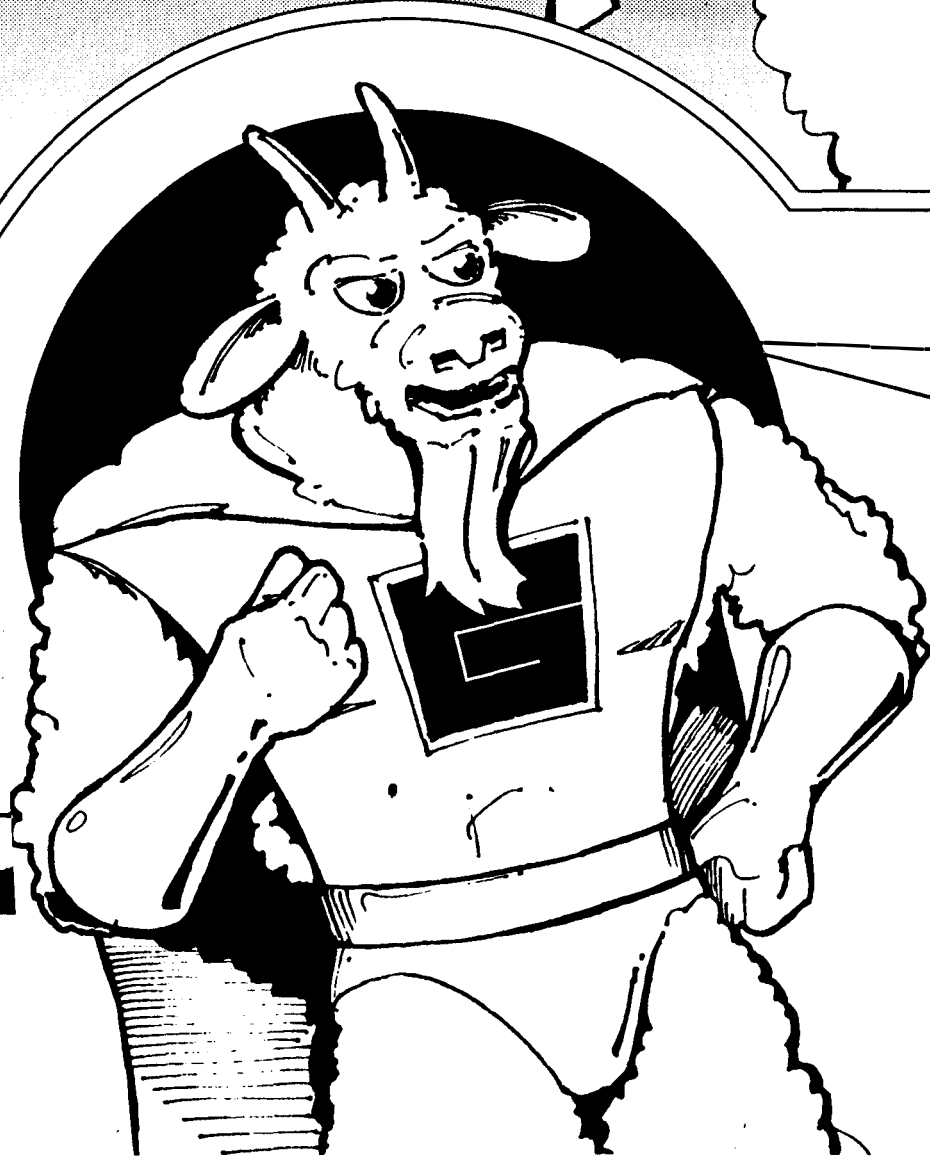


SOME MINES ARE KNOWN AS RECLAIMED MINES. THEY USED TO LOOK LIKE ONE OF THE OTHER MINES I SHOWED YOU, BUT NOW THEY HAVE BEEN CLEANED UP AND DIRT HAS BEEN SPREAD OVER THE MINE TO FILL IT IN. WHILE THERE MAY BE LESS RADIATION AROUND A RECLAIMED MINE, IT IS STILL DANGEROUS. RECLAIMED AREAS ARE NOT GOOD PLACES FOR OFF-ROADING. THE GROUND IS UNSTABLE AND COULD FALL IN AROUND YOU.





IT IS JUST ABOUT TIME FOR ME TO LEAVE. SOMEWHERE ELSE ON THE NAVAJO NATION, THERE ARE OTHERS IN NEED OF MY HELP.




BUT, BEFORE I GO, LET'S REVIEW THE IMPORTANT INFORMATION YOU HAVE LEARNED ABOUT SAFETY AND ABANDONED URANIUM MINES.

ONCE YOU KNOW YOUR FACTS, YOU WILL BE ABLE TO SHARE THESE SAFETY TIPS WITH YOUR FRIENDS AND FAMILY!

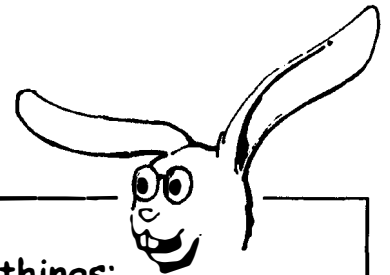
# ABANDONED MINE SAFETY REVIEW



## ... Gamma's Safety Tips

- Look for fences and warning signs with the radiation symbol, , which stands for dangerous radiation. If you see a sign or fence with this symbol, **STAY AWAY!**
- The fences and warning signs at some mines may have been cut or fallen down. If it looks like it could be a mine site, **STAY AWAY!**
- Don't play near mine or shaft openings. Loose rocks, tunnels, and old wood could fall on you.
- Don't take any rocks you see from a mine site home with you. Also, leave alone any other objects you may come upon. Rocks and other materials could contain dangerous radiation.
- Some open pit mines fill up with water. Don't drink or swim in a mine, it could make you very sick!
- Don't play on or around reclaimed mines. They have their own hidden dangers. The ground is often less stable than in other areas, and it could cave in on you.

## .. Rad Rabbit's Safety Lesson



You can avoid harmful radiation by remembering to do three things:

**Decrease TIME** - around the mine. One to two minutes probably won't hurt you.

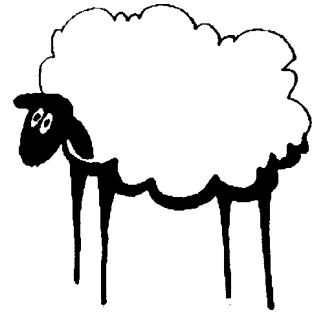
**Increase DISTANCE** - from the mine. The length of a school bus is a good distance, but two school buses would be better..

**Increase SHIELDING** - at the mine. Wear protective clothes and gloves.

# Find Your Way Around An Old Abandoned Mine

Circle the words hidden below to see how well you know  
your way around an old mine site.

Don't be Sheepish!



Words:

radiation  
shielding

uranium  
distance

black  
time

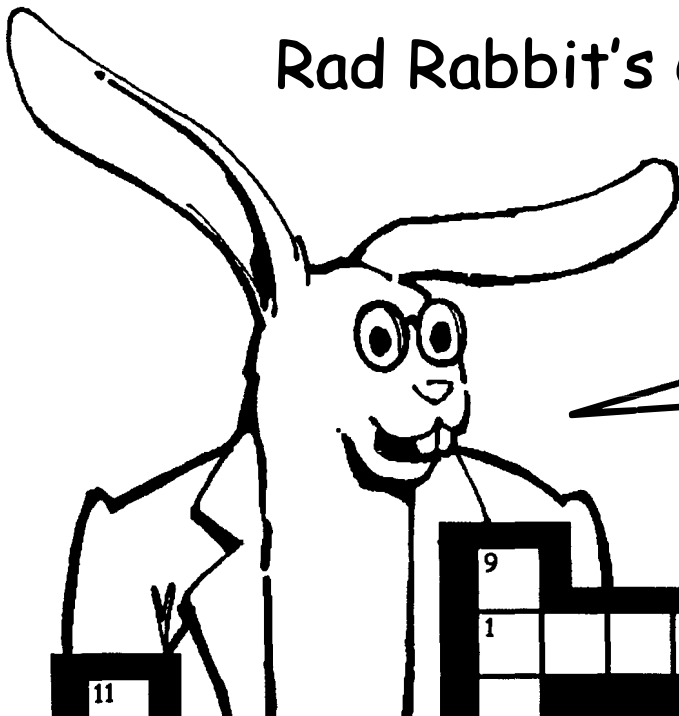
yellow  
radon

mine  
shaft

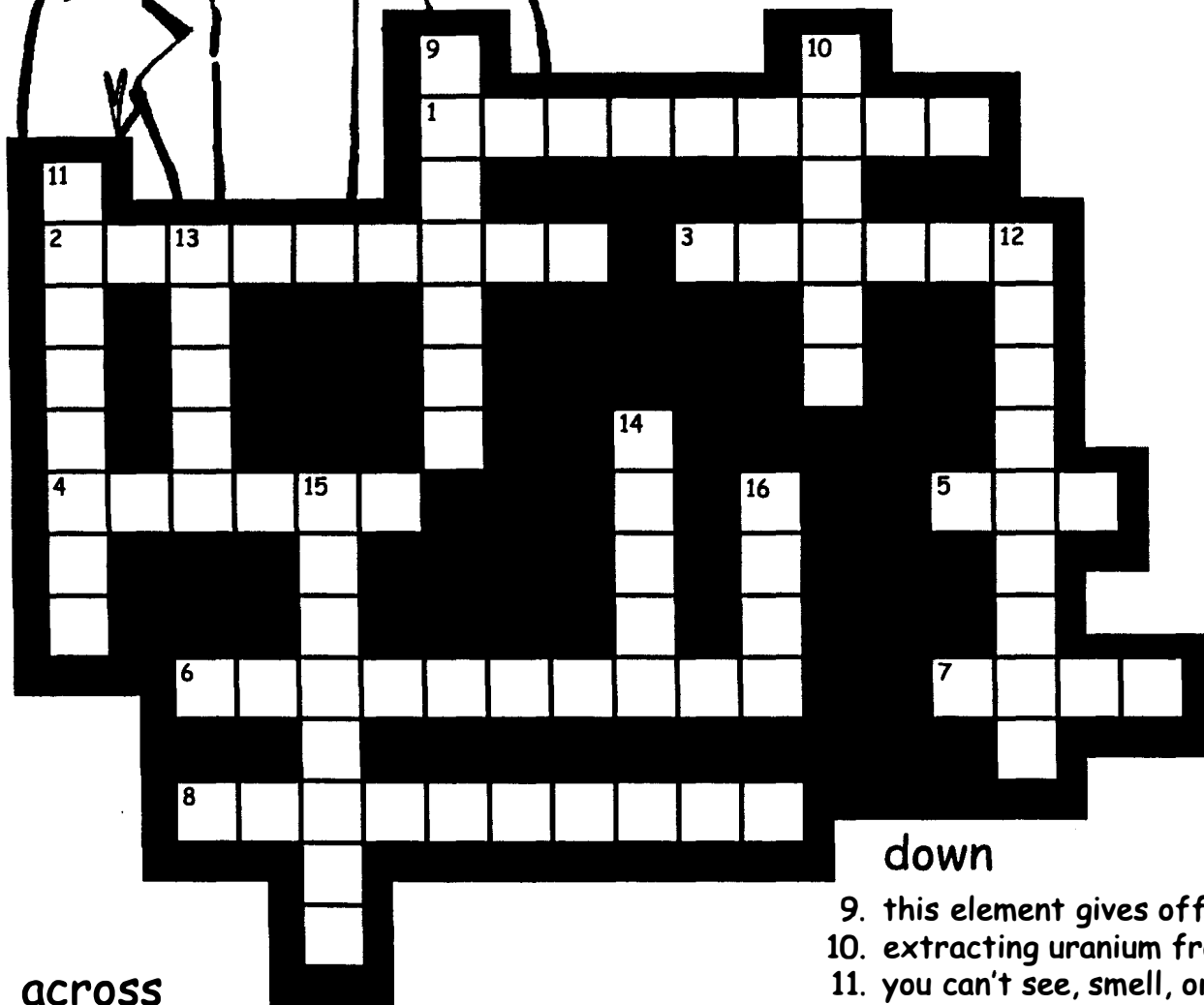
pit  
debris

A	B	C	D	E	F	Y	O	T	I	M	E	J	T	M
P	O	N	E	L	A	L	T	I	Q	I	P	K	R	Y
Q	S	H	B	E	A	F	M	E	R	N	E	G	L	U
A	S	I	R	W	A	Z	C	M	L	E	D	F	K	R
E	D	N	I	H	M	Y	O	P	J	B	H	M	J	A
R	C	Q	S	H	I	E	L	D	I	N	G	N	T	N
N	G	L	E	T	J	D	P	I	T	V	R	M	E	I
O	H	P	S	A	R	W	I	S	O	C	I	O	T	U
I	J	Q	B	J	M	L	P	T	O	N	L	P	Y	M
T	K	L	A	S	Q	I	I	A	P	K	W	I	Q	H
A	T	O	X	N	W	P	M	N	B	C	A	Y	W	I
I	P	S	O	B	M	L	O	C	U	A	Z	R	S	K
D	L	D	Q	E	R	T	Y	E	L	L	O	W	X	L
A	A	W	D	S	G	J	H	K	L	B	D	D	L	M
R	S	C	C	S	E	R	Y	U	K	L	Z	C	D	M

# Rad Rabbit's Crossword Puzzle



Test your knowledge of uranium with this crossword puzzle. If you get stuck, the words you need are at the bottom of the page.



## across

1. energy given off in the form of particles and rays.
2. an \_\_\_\_\_ mine is closed or forgotten
3. a \_\_\_\_\_ counter is used to detect radiation
4. New Mexico town with a uranium museum
5. a unit of radiation
6. another name for processed uranium
7. \_\_\_\_\_ particles can go through the first few layers of your skin
8. capitol of Navajo Nation and location of Navajo Nation EPA

## down

9. this element gives off radiation
10. extracting uranium from the ground
11. you can't see, smell, or feel this (two words)
12. a cleaned-up mine area has been \_\_\_\_\_
13. this particle is the most damaging inside your body
14. these rays can pass right through your body
15. mill \_\_\_\_\_ are a mixture of uranium and water left over from milling
16. this "debris \_\_\_\_\_" was left at the mine site

WINDY ROCK, BETA, RADIATION, MINING, ABANDONED, YELLOWCAKE, GAMMA, GEIGER, ALPHA, URANIUM, RAD, GRANTS, PILE, RADON GAS, RECLAIMED, TAILINGS



# URANIUM WORD SCRAMBLE

Unscramble the words below and write them in the spaces to the right. Then, take each letter from the underlined spaces below to decode the special message from Gamma Goat....If you have trouble with any of the words, look in the glossary at the back.

1) SDSCEERPO

\_\_\_\_\_

2) TIDONAIAR

\_\_\_\_\_

3) DDANOEBAN

\_\_\_\_\_

4)  YLMSBO

\_\_\_\_\_

5) ARNDO

\_\_\_\_\_

6) WLELOKECYA

\_\_\_\_\_

7) NRUIAUM

\_\_\_\_\_

8) MAGRAYAM

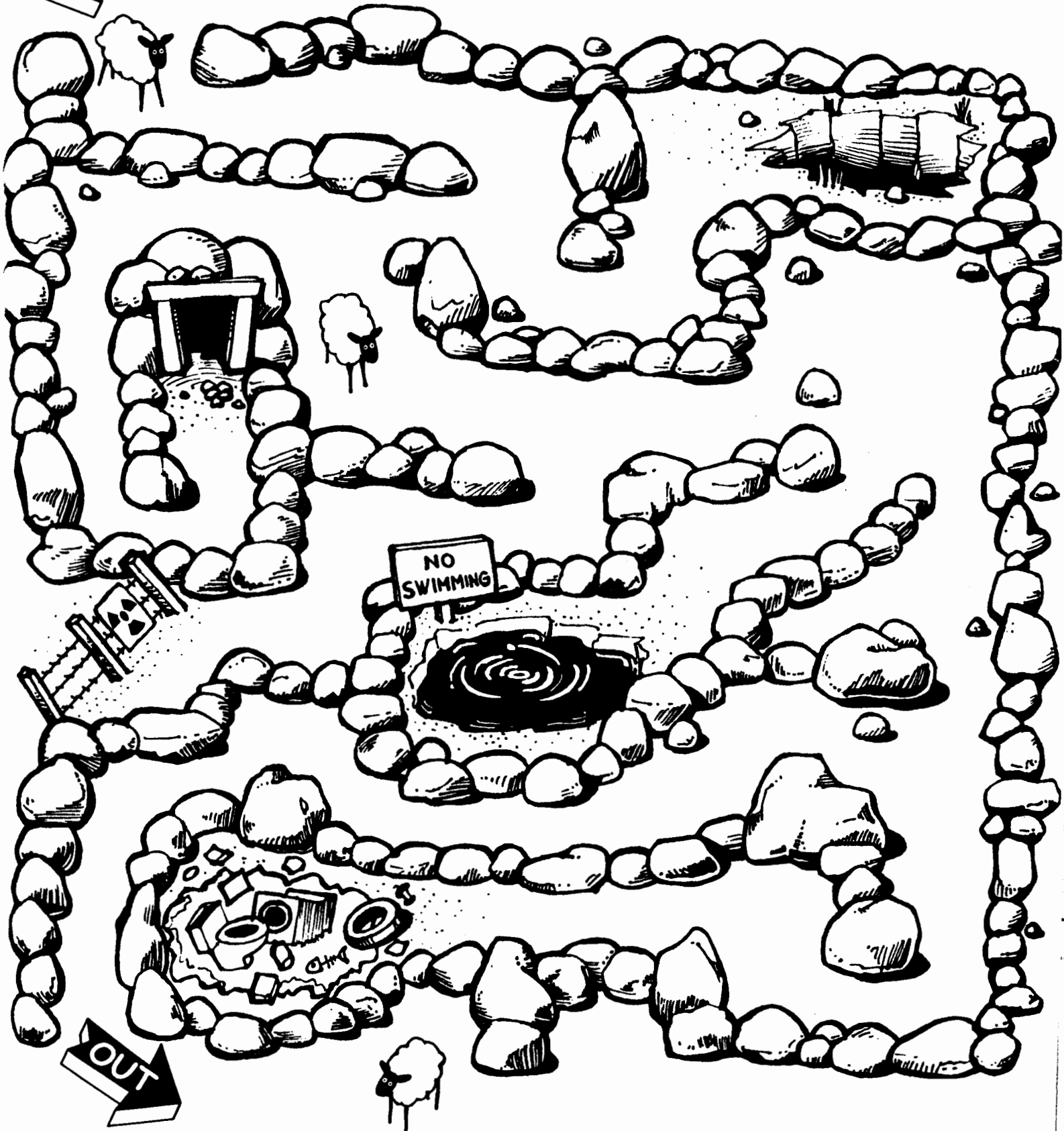
\_\_\_\_\_

What is the best thing you can do when you come upon an old mine?

" \_\_\_\_\_ !"

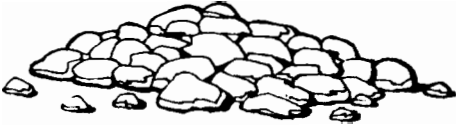
# WE'VE LOST OUR FRIEND!

CAN YOU HELP US FIND HIM WHILE AVOIDING POSSIBLE DANGER FROM RADIATION?

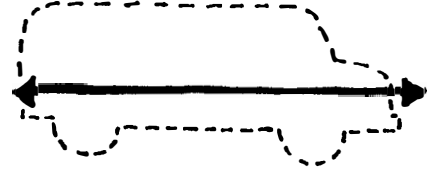


# A Picture is Worth a Thousand Words

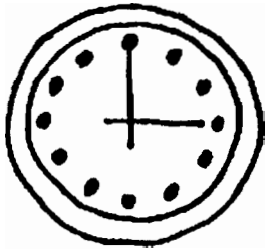
Draw a line from each word or phrase below to match it with the correct picture.



radiation symbol



time



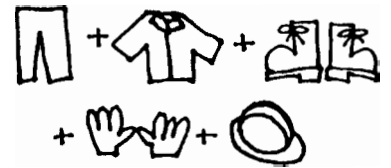
distance



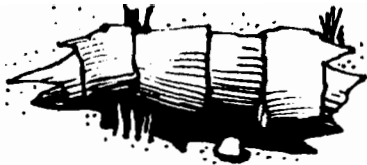
shielding



debris pile



uranium



gamma goat



mine pit

# GAMMA'S GLOSSARY

Here are the words Gamma and Rad talked about earlier. If you understand these, you are on your way to knowing how to be safe around old mines. (They will also help you solve the word scramble!)

**abandoned** ¥ left alone or forgotten. Many old uranium mines on the Navajo Nation have been abandoned. Since they have been left alone or forgotten, many are unsafe to be around. To avoid getting hurt, you should stay away!

**alpha particles** ¥ one of the three types of radiation given off by uranium. Alpha particles inside your body can be very damaging, but they can be blocked by a piece of paper.

**beta particles** ¥ one of the three types of radiation given off by uranium. Once it is inside your body it is less damaging than alpha particles, but it is stronger and will go through your skin more easily. Beta particles can be blocked by a thin sheet of metal or plastic.

**debris pile** ¥ a collection of rocks and discarded mining materials left at a mine site.

**element** ¥ a substance that occurs naturally in the earth's crust and is made up of atoms. Uranium is an element.

**exposure** • the act or condition of being subjected to radiation. This means that if you are in an area where there is radiation, your body will absorb some of the alpha, beta, and gamma rays that radiation gives off. This is called exposure. To reduce exposure, follow the lessons learned earlier of time, distance, and shielding.

**extract** ¥ to take out. Uranium miners extract rocks containing uranium from the ground and send them to a mill. At the mill, uranium is extracted from the rocks and processed.

**gamma rays** ¥ one of the three types of radiation given off by uranium. While it is the strongest and most penetrating radiation of the three, it is the least damaging to your body. It can be stopped by a thick slab of concrete or lead.

**geiger counter** ¥ an instrument for detecting the presence and intensity (strength) of radiation. Rad Rabbit uses a geiger counter to find out where the radiation is located and how strong it is.

**mine** ¥ a place where miners dig into the ground to find different types of rocks and metals.

**miner** ¥ a person who digs rocks and metals out of the ground.


**mineral** • a naturally occurring substance found in the earth such as stone, coal, salt, sulfur, sand, petroleum, water or natural gas.

**mining** • the process of taking (extracting) rocks and metals out of the ground.

**processed** • put through a series of actions or operations to change into another form. Uranium is processed at a mill so that it is in a usable form to make energy and weapons.

**rad** • a unit of radiation (defined below). Also, the name for Rad Rabbit.

**radiation** • the energy given off by atoms when they are moving or changing state. Uranium gives off radiation in the form of alpha, beta, and gamma rays. Radiation in large doses can be very bad for your health, leading to cancer, skin rashes, and over long periods of exposure, even death.

 the symbol for radiation. It stands for danger. It means that there is radiation in the area and you should stay away or it could make you sick (see definition for radiation, above).

**radon gas** • an invisible gas (can't see, taste, or smell it!) which occurs in nature. It comes from the breakdown of uranium found in the earth's crust.

**reclaimed** • made usable again. To change back to original form. Many abandoned mines on the Navajo Nation have been reclaimed. This means that they have been cleaned up and may not be as dangerous as the old mines. They still are not good places to play, and you should stay away.

**tailings** • a mixture of uranium and water leftover from the milling process. Also known as mill tailings.

**unstable** • not steady in action or movement.

**uranium** • an element which occurs naturally in many rocks in the earth's crust. It is usually yellowish or black in color. Uranium is the heaviest naturally occurring element!

**uranium mill** • a place where uranium is taken after it is mined to change it into a more usable form (processing uranium)

**uranium reserves** • areas where there are a large amount of naturally occurring uranium in the earth's crust which can be mined for a profit. The Navajo Nation, located on the Colorado Plateau, has some of the largest uranium reserves in the country.

**yellowcake** • another name for uranium ore, once it is removed from the rock (processed). Uranium is often called yellowcake by miners because it is yellowish in color.