

1 03:17:10:29 03:17:14:11 Annenberg Media  
2 03:17:14:13 03:17:18:10 §  
3 03:17:18:12 03:17:21:09 CAPTIONING MADE POSSIBLE BY  
SOUTHERN CALIFORNIA CONSORTIUM  
4 03:18:04:27 03:18:07:21 ONE OF THE MOST  
EXTRAORDINARY MOMENTS  
5 03:18:07:23 03:18:09:08 IN HUMAN HISTORY  
OCCURRED  
6 03:18:09:10 03:18:12:07 WHEN ASTRONAUTS FIRST  
SET FOOT ON THE MOON.  
7 03:18:13:24 03:18:16:27 AND YET, ON THE SURFACE  
OF OUR OWN PLANET,  
8 03:18:16:29 03:18:18:27 THERE LIE TRACTS  
OF TERRITORY  
9 03:18:18:29 03:18:21:12 WHERE NO ONE  
HAS EVER WALKED.  
10 03:18:21:14 03:18:24:08 ONLY A VERY SMALL GROUP  
OF PEOPLE  
11 03:18:24:10 03:18:26:22 HAS EVEN GLIMPSED THIS PLACE  
FIRST-HAND.  
12 03:18:34:24 03:18:36:07 IT'S NOT TOO SURPRISING  
13 03:18:36:09 03:18:38:07 THAT HUMANS  
HAVEN'T ACTUALLY WALKED  
14 03:18:38:09 03:18:40:23 ON THE FLOOR  
OF THE DEEP OCEAN  
15 03:18:40:25 03:18:42:07 CONSIDERING  
THE EXTREME CONDITIONS  
16 03:18:42:09 03:18:44:08 THAT EXIST  
IN THAT ENVIRONMENT.  
17 03:18:44:10 03:18:47:07 ON THE EARTH'S SURFACE,  
IS SUNLIGHT AND WARMTH,  
18 03:18:47:09 03:18:50:22 BUT THE DEEP SEA FLOOR  
IS IN ABSOLUTE DARKNESS  
19 03:18:50:24 03:18:52:04 WITH TEMPERATURES  
NEAR FREEZING.  
20 03:18:52:06 03:18:54:21 A PERSON STANDING  
ON THE OCEAN FLOOR  
21 03:18:54:23 03:18:57:08 WOULD BE EXPOSED  
TO THE TREMENDOUS WEIGHT  
22 03:18:57:10 03:18:58:23 OF THE OVERLYING WATER.  
23 03:18:58:25 03:19:00:08 THIS COLUMN OF WATER,  
24 03:19:00:10 03:19:03:08 WHICH IS OVER 3 1/2  
KILOMETERS HIGH,  
25 03:19:03:10 03:19:05:21 EXERTS A PRESSURE  
HUNDREDS OF TIMES  
GREATER  
26 03:19:05:23 03:19:07:19 THAN ATMOSPHERIC  
PRESSURE ON EARTH.  
27 03:19:07:21 03:19:10:19 A PERSON MY SIZE  
WOULD BE EXPOSED  
28 03:19:10:21 03:19:14:04 TO A TOTAL FORCE  
OF ABOUT  
9 MILLION KILOGRAMS.  
29 03:19:14:06 03:19:17:06 THAT'S ABOUT 100 TIMES  
THE WEIGHT OF THIS SHIP.  
30 03:19:17:08 03:19:19:21 THAT FORCE

31 03:19:19:23 03:19:22:05 TO THE SIZE  
 CRUSH MY BODY  
 32 03:19:22:07 03:19:23:19 THOUGH SCIENTISTS  
 DON'T WALK  
 33 03:19:23:21 03:19:26:05 ON THE FLOOR  
 OF THE OCEAN  
 34 03:19:26:07 03:19:29:04 DOESN'T MEAN WE KNOW  
 NOTHING ABOUT IT.  
 35 03:19:29:06 03:19:30:21 USING RESEARCH  
 SUBMERSIBLES  
 36 03:19:30:23 03:19:32:06 WHICH ARE  
 SPECIALLY DESIGNED  
 37 03:19:32:08 03:19:34:05 TO WITHSTAND THE  
 TREMENDOUS PRESSURES,  
 38 03:19:34:07 03:19:37:05 SCIENTISTS  
 HAVE EXAMINED PORTIONS  
 OF THE OCEAN FLOOR  
 39 03:19:37:07 03:19:38:22 IN PERSON.  
 40 03:19:38:24 03:19:41:12 BY PEERING THOUGH  
 WINDOWS 1/2 METER  
 IN THICKNESS.  
 41 03:19:41:14 03:19:44:20 EACH WINDOW IS MADE  
 OF A SINGLE FLAWLESS  
 QUARTZ CRYSTAL.  
 42 03:19:44:22 03:19:47:17 IT'S MOUNTED  
 IN A TITANIUM METAL  
 PRESSURE HULL  
 43 03:19:47:19 03:19:48:17 1 METER THICK.  
 44 03:19:48:19 03:19:50:19 MOST OF WHAT WE KNOW  
 45 03:19:50:21 03:19:52:02 ABOUT THIS  
 ALIEN ENVIRONMENT  
 46 03:19:52:04 03:19:55:03 HAS NOT BEEN LEARNED  
 BY PERSONAL OBSERVATION.  
 47 03:19:55:05 03:19:57:20 IT'S BEEN OBTAINED  
 BY USING  
 INDIRECT TECHNIQUES.  
 48 03:19:57:22 03:20:00:04 THE HIGH TECHNOLOGY  
 OF SEA FLOOR  
 EXPLORATION  
 49 03:20:00:06 03:20:02:06 HAS PRODUCED  
 A WIDE VARIETY  
 50 03:20:02:08 03:20:04:21 OF REMOTE  
 SAMPLING TOOLS  
 AND MARINE ROBOTS  
 51 03:20:04:23 03:20:09:05 THAT ACT AS THE EYES  
 AND THE EARS  
 AND THE HANDS  
 52 03:20:09:07 03:20:12:19 OF THE SCIENTISTS  
 WHO STUDY  
 THE DEEP OCEAN FLOOR.  
 53 03:20:12:21 03:20:14:03 USING THESE  
 REMOTE TECHNIQUES  
 54 03:20:14:05 03:20:16:18 HAS PRODUCED A VAST  
 WEALTH OF INFORMATION.

55 03:20:16:20 03:20:19:03 THE MORE WE LEARN  
ABOUT IT,

56 03:20:19:05 03:20:21:02 THE MORE INTRIGUING  
IT SEEMS.

57 03:20:21:04 03:20:24:17 THE DEEP SEA FLOOR  
HAS PLAYED  
A PROMINENT ROLE

58 03:20:24:19 03:20:26:19 IN THE EVOLUTION  
OF OUR PLANET.

59 03:20:26:21 03:20:29:22 IT REMAINS THE MOST  
TECTONICALLY VIGOROUS  
REGION ON EARTH.

60 03:20:29:24 03:20:32:08 *WE CALL OUR WORLD  
PLANET EARTH.*

61 03:20:32:10 03:20:35:08 *A MORE APT NAME  
MIGHT BE PLANET OCEAN,*

62 03:20:35:10 03:20:38:07 *SINCE THE OCEANS COVER  
MORE THAN 70%*

63 03:20:38:09 03:20:40:04 *OF THE GLOBE'S SURFACE.*

64 03:20:40:06 03:20:43:04 *THIS VAST AMOUNT OF WATER  
PROBABLY GREW*

65 03:20:43:06 03:20:45:18 *FROM THE CONDENSATION  
OF VOLCANIC STEAM*

66 03:20:45:20 03:20:48:18 *AND FROM THE MELTING  
OF ICE IN COMETS*

67 03:20:48:20 03:20:50:24 *WHICH STRUCK  
THE PRIMEVAL EARTH.*

68 03:20:50:26 03:20:52:10 *FROM THE BEGINNING,*

69 03:20:52:12 03:20:54:28 *THE OCEANS HAVE CONTAINED  
MORE THAN JUST WATER.*

70 03:20:55:00 03:20:58:20 *CARBON DIOXIDE, CHLORINE,  
AND SULFUR DIOXIDE,*

71 03:20:58:22 03:21:03:13 *WHICH ARE VOLCANIC GASES,  
DISSOLVE EASILY IN WATER.*

72 03:21:03:15 03:21:05:29 *SODIUM, MAGNESIUM,  
AND MANY OTHER ELEMENTS*

73 03:21:06:01 03:21:08:01 *WEATHERED FROM ROCKS  
ON LAND*

74 03:21:08:03 03:21:10:01 *CONTINUOUSLY POUR  
INTO THE SEA*

75 03:21:10:03 03:21:12:00 *FROM THE MOUTHS  
OF RIVERS.*

76 03:21:12:02 03:21:16:09 *THESE CHEMICALS  
MAKE OCEANS SALTY.*

77 03:21:16:11 03:21:19:08 *IF THE SURFACE OF EARTH  
WERE COMPLETELY LEVEL,*

78 03:21:19:10 03:21:22:09 *AN OCEAN WOULD COVER  
THE ENTIRE PLANET,*

79 03:21:22:11 03:21:25:25 *BUT THE SURFACE IS MADE UP  
OF TWO CONTRASTING MATERIALS.*

80 03:21:25:27 03:21:28:08 *LIGHT, GRANITIC ROCK  
FLOATS HIGH,*

81 03:21:28:10 03:21:30:20 *FORMING THE WORLD'S  
CONTINENTS.*

82 03:21:30:22 03:21:34:02 *THE HEAVIER BASALTIC ROCK  
TENDS TO SINK,*

83 03:21:34:04 03:21:37:22 FORMING THE WORLD'S  
DEEP OCEAN BASINS.

84 03:21:37:24 03:21:41:07 THE OCEANS AVERAGE BETWEEN  
3 AND 4 KILOMETERS DEEP.

85 03:21:41:09 03:21:44:07 HOWEVER, COMPARED TO  
THE TOTAL DIAMETER OF EARTH,

86 03:21:44:09 03:21:47:22 THE OCEANS ARE  
BUT A PATCHY FILM OF LIQUID

87 03:21:47:24 03:21:49:11 COVERING THE SURFACE.

88 03:21:49:13 03:21:51:25 SCIENTISTS HAVE IDENTIFIED  
SEVERAL DIFFERENT REGIONS

89 03:21:51:27 03:21:53:10 OF THE SEA FLOOR.

90 03:21:53:12 03:21:56:01 MOST OF US HAVE HAD  
FIRST-HAND EXPERIENCE

91 03:21:56:03 03:21:59:00 WITH THE SHALLOWEST  
AND MOST ACCESSIBLE AREA--

92 03:21:59:02 03:22:00:28 THE CONTINENTAL SHELF.

93 03:22:01:00 03:22:03:06 WHEN WE WADE  
IN THE OCEAN,

94 03:22:03:08 03:22:05:06 WE'RE WALKING  
AT THE LANDWARD EDGE

95 03:22:05:08 03:22:06:25 OF A CONTINENTAL SHELF.

96 03:22:06:27 03:22:09:08 SHELVES COVER 1/6  
OF EARTH'S SURFACE,

97 03:22:09:10 03:22:12:06 SLOPING GENTLY DOWN  
FROM SHORELINES

98 03:22:12:08 03:22:15:21 AT AN ANGLE OF ABOUT  
1/10 OF A DEGREE.

99 03:22:15:23 03:22:19:10 WORLDWIDE, SHELVES AVERAGE  
70 KILOMETERS IN WIDTH,

100 03:22:19:12 03:22:22:10 BUT IN SOME REGIONS,  
NOTABLY THE PACIFIC COAST,

101 03:22:22:12 03:22:26:16 SHELVES CAN BE AS NARROW  
AS 2 KILOMETERS.

102 03:22:26:18 03:22:29:00 IF WE STARTED  
AT THE BEACH

103 03:22:29:02 03:22:31:14 AND WENT TOWARDS  
THE DEEP OCEAN,

104 03:22:31:16 03:22:34:00 WE'D SEE FIRST  
THE CONTINENTAL SHELF,

105 03:22:34:02 03:22:37:29 THEN A DISTINCT  
BREAK IN SLOPE, AND  
IT'S SUDDENLY STEEP.

106 03:22:38:01 03:22:41:00 THAT'S THE GEOLOGIC EDGE  
OF THE CONTINENT,

107 03:22:41:02 03:22:43:29 SO IT'S SHALLOW  
AT ABOUT 200 METERS DEPTH.

108 03:22:44:01 03:22:46:29 THOUGH IT VARIES  
FROM PLACE TO PLACE.

109 03:22:47:01 03:22:48:14 SUDDENLY IT'S STEEP.

110 03:22:48:16 03:22:52:13 THEN IT DROPS  
ALL THE WAY TO 4  
OR 6 KILOMETERS

111 03:22:52:15 03:22:53:29 TO THE DEEP OCEAN,

112 03:22:54:01 03:22:56:15 SO THAT'S  
A VERY TALL SCARP

113 03:22:56:17 03:22:58:29 FROM THE EDGE  
 OF THE CONTINENTAL SHELF  
 114 03:22:59:01 03:23:00:15 TO THE DEEP OCEAN.  
 115 03:23:00:17 03:23:02:14 THAT'S CALLED  
 THE CONTINENTAL SLOPE.  
 116 03:23:02:16 03:23:05:14 WHEN YOU GET  
 TO THE BASE OF THE SLOPE,  
 117 03:23:05:16 03:23:07:27 THERE'S A HUGE,  
 LONG, SHALLOW SLOPE  
 118 03:23:07:29 03:23:11:12 WHERE ALL THE DEBRIS  
 THAT'S COMING OFF  
 THE CONTINENT  
 119 03:23:11:14 03:23:12:27 IS DEPOSITED.  
 120 03:23:12:29 03:23:15:26 IT'S A GRADUAL SLOPE  
 THAT'S CALLED  
 THE CONTINENTAL RISE.  
 121 03:23:15:28 03:23:18:28 IF YOU WERE COMING  
 TOWARDS THE CONTINENT,  
 122 03:23:19:00 03:23:20:28 YOU'D SLOWLY RISE  
 UP IT.  
 123 03:23:21:00 03:23:23:27 IT'S ALL THE DEBRIS  
 FROM THE RIVERS  
 124 03:23:23:29 03:23:25:27 AND OFF  
 OF THE SLOPE  
 125 03:23:25:29 03:23:27:26 BY A LOT  
 OF DIFFERENT PROCESSES,  
 126 03:23:27:28 03:23:30:27 END UP IN A PILE  
 SLOWLY GETTING THINNER  
 127 03:23:30:29 03:23:34:13 AS YOU GO AWAY  
 FROM THE BASE  
 OF THE SLOPE.  
 128 03:23:34:15 03:23:35:29 *IN MANY PLACES,*  
 129 03:23:36:01 03:23:38:13 *THE CONTINENTAL SHELVES*  
*AND SLOPES ARE FURROWED*  
 130 03:23:38:15 03:23:41:26 *BY DEEP V-SHAPED VALLEYS*  
*KNOWN AS SUBMARINE CANYONS.*  
 131 03:23:41:28 03:23:43:27 *WHERE THE SHELF IS WIDE,*  
 132 03:23:43:29 03:23:46:27 *AS ON THE ATLANTIC COAST*  
*OF THE UNITED STATES,*  
 133 03:23:46:29 03:23:49:13 *THESE CANYONS BEGIN*  
*FAR OUT FROM SHORE*  
 134 03:23:49:15 03:23:51:28 *NEAR THE OUTER EDGE*  
*OF THE SHELF.*  
 135 03:23:52:00 03:23:53:28 *ON THE NARROW*  
*CONTINENTAL SHELVES*  
 136 03:23:54:00 03:23:55:18 *OF THE PACIFIC COAST,*  
 137 03:23:55:20 03:23:59:17 *THE HEADS OF SOME CANYONS*  
*LIE CLOSE TO THE SURF ZONE.*  
 138 03:23:59:19 03:24:02:04 THEY'VE BEEN A MYSTERY  
 FOR A LONG TIME.  
 139 03:24:02:06 03:24:05:02 WHY THEY'RE THERE,  
 HOW THEY'RE CUT  
 SO DEEP.  
 140 03:24:05:04 03:24:06:15 THEY'RE ALSO  
 VERY INTERESTING.  
 141 03:24:06:17 03:24:10:11 A LOT OF

THE SEDIMENT THAT COMES  
 OFF THE CONTINENT  
 142 03:24:10:13 03:24:13:00 AND ONTO THE OCEAN FLOOR  
 GOES DOWN THOSE CANYONS  
 143 03:24:13:02 03:24:15:09 AND DEBOUCHES  
 ONTO THE OCEAN FLOOR--  
 144 03:24:15:11 03:24:20:01 MAKES FANS OF SEDIMENT  
 AT THE FOOT  
 OF THE SLOPE.  
 145 03:24:20:03 03:24:21:18 *BEYOND*  
*THE CONTINENTAL RISE*  
 146 03:24:21:20 03:24:25:15 *LIES WHAT IS QUITE LITERALLY*  
*THE FLATTEST REGION ON EARTH.*  
 147 03:24:25:17 03:24:27:03 *THE ABYSSAL PLAIN.*  
 148 03:24:27:05 03:24:29:11 *THIS LANDSCAPE IS FORMED*  
 149 03:24:29:13 03:24:32:10 *AS LAYER UPON LAYER*  
*OF SEDIMENT SETTLES*  
 150 03:24:32:12 03:24:34:09 *ON THE OCEAN FLOOR.*  
 151 03:24:34:11 03:24:37:25 *THIS MATERIAL, KNOWN*  
*AS PELAGIC SEDIMENT,*  
 152 03:24:37:27 03:24:41:09 *CONSISTS OF ORGANIC*  
*AS WELL AS INORGANIC MATTER.*  
 153 03:24:42:21 03:24:44:26 *PELAGIC SEDIMENTATION*  
*IS NOT RESTRICTED*  
 154 03:24:44:28 03:24:46:26 *TO THE ABYSSAL PLAIN,*  
 155 03:24:46:28 03:24:49:08 *BUT OCCURS*  
*THROUGHOUT THE OCEANS.*  
 156 03:24:50:21 03:24:53:09 THE PELAGIC SEDIMENTS  
 ARE MADE  
 OF THE DEBRIS  
 157 03:24:53:11 03:24:56:09 THAT FALLS OUT  
 OF THE WATER COLUMN.  
 158 03:24:56:11 03:24:57:26 IT'S LIKE A SNOWFALL  
 159 03:24:57:28 03:25:00:11 THAT FALLS ON TOP  
 OF THE TOPOGRAPHY,  
 160 03:25:00:13 03:25:03:10 AND THEY'RE MADE OF  
 THE MICROSCOPIC SHELLS  
 161 03:25:03:12 03:25:05:25 OF ORGANISMS  
 IN THE PLANKTON,  
 162 03:25:05:27 03:25:09:08 AND ALSO ALL THE CLAY  
 AND DUST IN THE AIR  
 163 03:25:09:10 03:25:12:15 THAT FALLS DOWN  
 OR IS STIRRED UP  
 IN THE WATER.  
 164 03:25:12:17 03:25:14:15 THESE SEDIMENTS  
 COME DOWN GENTLY  
 165 03:25:14:17 03:25:16:15 AND DRAPE  
 OVER THE TOPOGRAPHY.  
 166 03:25:16:17 03:25:19:09 IT SAVES  
 ALL THE MOUNTAINS  
 AND HILLS STRUCTURE,  
 167 03:25:19:11 03:25:21:23 EVEN THOUGH  
 IT SOFTENS THEM UP  
 168 03:25:21:25 03:25:23:08 LIKE A SNOWFALL WOULD.  
 169 03:25:23:10 03:25:25:23 *FARTHER OUT*  
*ALONG THE ABYSSAL PLAIN,*

170 03:25:25:25 03:25:28:08 THE SEA FLOOR BEDROCK  
 BECOMES SHALLOWER,  
 171 03:25:28:10 03:25:30:19 AND THE SEDIMENTARY COVER  
 BECOMES THINNER,  
 172 03:25:30:21 03:25:32:04 EXPOSING LAVA HILLS,  
 173 03:25:32:06 03:25:35:09 WHICH ARE ACTUALLY THE TOPS  
 OF VOLCANOES.  
 174 03:25:35:11 03:25:36:24 THOUSANDS  
 OF THESE VOLCANOES  
 175 03:25:36:26 03:25:39:23 ARE SCATTERED ACROSS  
 THE DEEP OCEAN FLOOR.  
 176 03:25:39:25 03:25:42:22 THE LARGER ONES  
 ARE CALLED SEA MOUNTS.  
 177 03:25:44:13 03:25:47:07 IN FACT, UNDERNEATH THE VENEER  
 OF SEDIMENTARY DEPOSITS,  
 178 03:25:47:09 03:25:50:07 THE ENTIRE SURFACE  
 OF THE SEA FLOOR  
 179 03:25:50:09 03:25:52:16 IS VOLCANIC IN ORIGIN,  
 180 03:25:52:18 03:25:55:16 ALTHOUGH FEW SIGNS OF  
 RECENT ERUPTIONS ARE VISIBLE  
 181 03:25:55:18 03:25:58:23 EXCEPT  
 AT MID-OCEAN RIDGES  
 182 03:25:58:25 03:26:02:08 RIDGES ARE BROAD,  
 MOUNTAINOUS FEATURES  
 183 03:26:02:10 03:26:04:09 RISING SOME  
 2 KILOMETERS HIGH  
 184 03:26:04:11 03:26:06:09 ABOVE THE SURROUNDING  
 SEA FLOOR  
 185 03:26:06:11 03:26:09:22 AND STRETCHING UP  
 TO 1,500 KILOMETERS WIDE.  
 186 03:26:09:24 03:26:12:21 THE RIDGES ARE CONNECTED  
 IN A SINGLE SYSTEM,  
 187 03:26:12:23 03:26:15:06 SNAKING ACROSS  
 THE UNDERSEA LANDSCAPE  
 188 03:26:15:08 03:26:17:06 FROM ONE OCEAN  
 TO ANOTHER--  
 189 03:26:17:08 03:26:21:06 WINDING AROUND THE GLOBE  
 LIKE THE SEAM ON A BASEBALL.  
 190 03:26:21:08 03:26:24:05 UNLIKE THE CREST  
 OF A CONTINENTAL MOUNTAIN BELT,  
 191 03:26:24:07 03:26:27:07 WHICH USUALLY CONSISTS  
 OF A SERIES OF TALL PEAKS,  
 192 03:26:27:09 03:26:29:22 THE CREST  
 OF A MID-OCEAN RIDGE  
 193 03:26:29:24 03:26:32:06 IS OCCUPIED  
 BY A CLIFF-RIMMED VALLEY  
 194 03:26:32:08 03:26:34:06 EXTENDING ALONG  
 MUCH OF ITS LENGTH.  
 195 03:26:34:08 03:26:37:06 THE WALLS AND FLOOR  
 OF THIS VALLEY  
 196 03:26:37:08 03:26:39:08 ARE SPLIT  
 BY NUMEROUS FISSURES.  
 197 03:26:39:10 03:26:41:05 IT'S IN  
 THIS FISSURED VALLEY  
 198 03:26:41:07 03:26:44:06 THAT THE MOST FREQUENT  
 VOLCANIC ACTION OCCURS

199 03:26:44:08 03:26:45:22 ON THE OCEAN FLOOR  
 200 03:26:45:24 03:26:48:21 IN THE FORM OF UNDERSEA  
 LAVA FLOWS.  
 201 03:26:48:23 03:26:51:05 THIS VOLCANIC ACTIVITY  
 IS THE KEY  
 202 03:26:51:07 03:26:54:06 TO A PHENOMENON THAT  
 LONG-PUZZLED GEOLOGISTS.  
 203 03:26:54:08 03:26:56:06 THERE WAS  
 A GREAT DISPARITY  
 204 03:26:56:08 03:26:58:22 BETWEEN THE AGE  
 OF THE CONTINENTAL CRUST  
 205 03:26:58:24 03:27:01:07 AND THAT  
 OF THE OCEANIC CRUST.  
 206 03:27:01:09 03:27:03:07 THE ROCK UNDERLYING  
 THE CONTINENTS  
 207 03:27:03:09 03:27:06:06 IS AS MUCH  
 AS 4 BILLION YEARS OLD,  
 208 03:27:06:08 03:27:09:21 AND YET THE OLDEST ROCK  
 FOUND BENEATH THE OCEAN  
 209 03:27:09:23 03:27:12:25 DATES BACK ONLY  
 ABOUT 200 MILLION YEARS.  
 210 03:27:12:27 03:27:15:11 THE FACT  
 THAT THERE'S  
 NO OCEAN CRUST  
 211 03:27:15:13 03:27:18:07 ON EARTH OLDER THAN  
 200 MILLION YEARS  
 212 03:27:18:09 03:27:19:21 RAISES AN  
 INTRIGUING QUESTION.  
 213 03:27:19:23 03:27:22:16 DOES THIS MEAN OCEANS  
 DIDN'T EXIST ON EARTH  
 214 03:27:22:18 03:27:24:26 DURING THE PRECEDING  
 4.4 BILLION YEARS  
 215 03:27:24:28 03:27:26:06 OF EARTH HISTORY?  
 216 03:27:26:08 03:27:28:07 CLEARLY, THIS CAN'T  
 BE TRUE.  
 217 03:27:28:09 03:27:30:21 FOSSILS OF ORGANISMS  
 THAT LIVED IN THE SEA  
 218 03:27:30:23 03:27:34:07 ARE FOUND IN ROCKS OLDER  
 THAN 200 MILLION YEARS  
 219 03:27:34:09 03:27:36:06 ON EVERY CONTINENT  
 ON EARTH.  
 220 03:27:36:08 03:27:38:06 FOSSILS OF MULTICELLULAR  
 MARINE ANIMALS  
 221 03:27:38:08 03:27:42:06 RANGE IN AGE  
 BACK AT LEAST  
 670 MILLION YEARS,  
 222 03:27:42:08 03:27:44:22 AND EVIDENCE OF  
 COLONIAL MARINE ALGAE,  
 223 03:27:44:24 03:27:46:23 CALLED STROMATOLITES,  
 HAVE BEEN FOUND  
 224 03:27:46:25 03:27:49:22 IN THE OLDEST  
 SEDIMENTARY ROCKS  
 ON EARTH.  
 225 03:27:49:24 03:27:51:14 DISCOVERED IN  
 NORTHWEST AUSTRALIA,  
 226 03:27:51:16 03:27:54:05 THESE SEDIMENTARY ROCKS



AND THE STRAMATOLITES  
 THEY CONTAIN  
 227 03:27:54:07 03:27:56:06 ARE DEFINITELY  
 OF MARINE ORIGIN  
 228 03:27:56:08 03:28:00:22 AND RANGE IN AGE  
 BETWEEN 2.8  
 AND 3.5 BILLION YEARS.  
 229 03:28:00:24 03:28:02:22 IF THEN OCEANS  
 DID EXIST  
 230 03:28:02:24 03:28:04:22 THROUGHOUT MOST  
 OF EARTH HISTORY,  
 231 03:28:04:24 03:28:07:29 WHAT'S HAPPENED  
 TO ALL OF THE OLD  
 OCEAN CRUST?  
 232 03:28:08:01 03:28:11:04 ANALYSIS OF CORES  
 TAKEN FROM SUBMARINE ROCK  
 233 03:28:11:06 03:28:13:28 REVEALS THAT THE SEA BED  
 BECOMES STEADILY OLDER  
 234 03:28:14:00 03:28:17:19 WITH INCREASING DISTANCE  
 FROM THE MID-OCEAN RIDGES.  
 235 03:28:17:21 03:28:19:03 THIS RESEARCH INDICATES  
 236 03:28:19:05 03:28:22:02 THAT THE SEA FLOOR  
 ORIGINATES AND GROWS OUTWARD  
 237 03:28:22:04 03:28:23:19 FROM THE RIDGES.  
 238 03:28:23:21 03:28:28:20 GEOLOGISTS CALL THIS PROCESS  
 SEA-FLOOR SPREADING.  
 239 03:28:31:15 03:28:34:14 THE FISSURES ATOP  
 A MID-OCEAN RIDGE  
 240 03:28:34:16 03:28:37:09 ARE CONDUITS THROUGH WHICH  
 FRESH LAVA EMERGES.  
 241 03:28:37:11 03:28:38:18 THE LAVA HARDENS,  
 242 03:28:38:20 03:28:41:14 BUT SOON THE CRUST  
 IS PULLED OPEN  
 243 03:28:41:16 03:28:42:29 FORMING NEW FISSURES  
 244 03:28:43:01 03:28:45:19 AND ALLOWING MORE LAVA  
 TO EMERGE.  
 245 03:28:47:20 03:28:50:03 REPEATED CONTINUOUSLY  
 OVER MILLIONS OF YEARS,  
 246 03:28:50:05 03:28:53:05 THIS PROCESS  
 FORMS NEW SEA FLOOR.  
 247 03:28:53:07 03:28:56:05 AS THE SEA FLOOR IS  
 PULLED AWAY FROM THE RIDGE,  
 248 03:28:56:07 03:28:58:04 IT BECOMES COOLER  
 AND DENSER.  
 249 03:28:58:06 03:29:01:04 EVENTUALLY, IT BECOMES  
 SO COLD AND DENSE,  
 250 03:29:01:06 03:29:03:19 IT CAN SINK BACK  
 INTO THE MANTLE  
 251 03:29:03:21 03:29:06:17 AGAINST THE EDGE  
 OF A NEARBY CONTINENT  
 252 03:29:06:19 03:29:08:06 OR SMALLER OCEAN BASIN.  
 253 03:29:09:13 03:29:11:16 THIS SINKING  
 OF OCEANIC CRUST,  
 254 03:29:11:18 03:29:13:02 CALLED SUBDUCTION,  
 255 03:29:13:04 03:29:16:03 EXPLAINS THE ABSENCE  
 OF VERY ANCIENT SEA FLOOR.

256 03:29:16:05 03:29:19:20 QUITE SIMPLY, IT DISAPPEARS  
 BACK INTO THE EARTH.  
 257 03:29:22:19 03:29:24:02 SUBDUCTION BEGINS  
 258 03:29:24:04 03:29:25:16 AT ENORMOUS  
 UNDERWATER TRENCHES,  
 259 03:29:25:18 03:29:28:16 SOME OF THEM SEVERAL  
 TIMES DEEPER  
 260 03:29:28:18 03:29:30:03 THAN THE GRAND CANYON.  
 261 03:29:30:05 03:29:32:03 BECAUSE  
 OF THE GREAT DEPTH,  
 262 03:29:32:05 03:29:34:18 MARINE GEOLOGISTS  
 HAVE HAD TO COME UP  
 263 03:29:34:20 03:29:37:02 WITH A HOST  
 OF INGENIOUS WAYS  
 264 03:29:37:04 03:29:39:16 OF EXPLORING  
 THE DEEP SEA FLOOR.  
 265 03:29:39:18 03:29:42:02 THE PRIMARY TOOL  
 USED BY EARTH SCIENTISTS  
 266 03:29:42:04 03:29:44:01 TO STUDY  
 THE OCEAN FLOOR  
 267 03:29:44:03 03:29:46:16 IS A RESEARCH VESSEL  
 LIKE THIS,  
 268 03:29:46:18 03:29:48:03 OUTFITTED WITH A VARIETY  
 269 03:29:48:05 03:29:49:17 OF OCEANOGRAPHIC  
 SAMPLING INSTRUMENTS.  
 270 03:29:49:19 03:29:54:02 MOUNTED ON THE STERN  
 OF THE VESSEL IS THIS A-FRAME.  
 271 03:29:54:04 03:29:56:02 IT'S A HYDRAULICALLY  
 MOVABLE RACK  
 272 03:29:56:04 03:29:58:15 USED TO LIFT AND DEPLOY  
 THE INSTRUMENTS.  
 273 03:29:58:17 03:29:59:25 THE OCEANOGRAPHIC  
 SAMPLING INSTRUMENTS  
 274 03:29:59:27 03:30:02:23 ARE TETHERED TO THE VESSEL  
 WITH STEEL CABLE  
 275 03:30:02:25 03:30:04:29 WOUND AROUND  
 A REVOLVING DRUM.  
 276 03:30:05:01 03:30:07:16 SCIENTISTS CAN TAKE  
 A BITE OF SEDIMENT  
 277 03:30:07:18 03:30:09:01 FROM THE OCEAN BOTTOM  
 278 03:30:09:03 03:30:12:01 USING AN INSTRUMENT  
 LIKE THIS CAMEL GRAB.  
 279 03:30:12:03 03:30:13:21 IT TAKES SEDIMENT  
 SAMPLES QUICKLY,  
 280 03:30:13:23 03:30:17:06 BUT ONLY OF THE UPPER  
 CENTIMETERS OF OCEAN BOTTOM.  
 281 03:30:17:08 03:30:20:00 OFTENTIMES, AN UNDISTURBED  
 SAMPLE OF THE DEEPER LAYERS  
 282 03:30:20:02 03:30:21:29 IS REQUIRED  
 TO EXAMINE VARIATIONS  
 283 03:30:22:01 03:30:23:16 IN THE ACCUMULATED  
 SEDIMENT  
 284 03:30:23:18 03:30:26:00 ON THE OCEAN BOTTOM  
 WITH TIME.  
 285 03:30:26:02 03:30:29:00 THIS BOX CORER TAKES  
 AN ENTIRE COLUMN OF SEDIMENT

286 03:30:29:02 03:30:31:15 WHICH LATER  
CAN BE SPLIT OPEN

287 03:30:31:17 03:30:33:15 AND THE INDIVIDUAL  
LAYERS ANALYZED

288 03:30:33:17 03:30:36:04 LIKE PAGES IN A BOOK.

289 03:30:36:06 03:30:39:01 BUT MARINE GEOLOGISTS NEED  
MORE THAN PHYSICAL SAMPLES

290 03:30:39:03 03:30:40:15 TO UNDERSTAND  
THE SEA FLOOR.

291 03:30:40:17 03:30:43:01 IT'S LIKE TRYING  
TO UNDERSTAND AN ENTIRE CITY

292 03:30:43:03 03:30:46:00 BY ONLY VISITING  
CERTAIN BUILDINGS  
AND STREET CORNERS.

293 03:30:46:02 03:30:49:00 BY EXAMINING THE SHAPE  
AND GLOBAL DISTRIBUTION

294 03:30:49:02 03:30:50:15 OF SUBMARINE LAND FORMS

295 03:30:50:17 03:30:52:14 AND DETERMINING  
THEIR ROCK COMPOSITION,

296 03:30:52:16 03:30:55:14 GEOLOGISTS HAVE BEEN  
ABLE TO LINK THE PROCESSES

297 03:30:55:16 03:30:57:15 WHICH CREATE  
THESE LAND FORMS

298 03:30:57:17 03:31:00:15 WITH THE FORMATION  
OF THE OCEAN CRUST ITSELF.

299 03:31:00:17 03:31:02:00 MOST TOPOGRAPHIC  
MAPPING TECHNIQUES

300 03:31:02:02 03:31:03:29 USED IN  
SEA FLOOR EXPLORATION

301 03:31:04:01 03:31:06:28 ARE BASED ON THE PRINCIPLE  
OF SOUND WAVES

302 03:31:07:00 03:31:08:12 BOUNCED OFF  
THE SEA BOTTOM--

303 03:31:08:14 03:31:10:13 A TECHNIQUE CALLED  
ECHO SOUNDING.

304 03:31:10:15 03:31:12:28 FIRST DEVELOPED FOR  
THE MILITARY DETECTION

305 03:31:13:00 03:31:15:14 OF ENEMY SUBMARINES  
IN THE 1920s,

306 03:31:15:16 03:31:17:28 ECHO SOUNDING DEVICES  
EMIT A PULSE OF SOUND

307 03:31:18:00 03:31:19:14 TOWARD THE OCEAN BOTTOM,

308 03:31:19:16 03:31:21:28 RECORDING THE TIME  
IT TAKES FOR THAT SOUND

309 03:31:22:00 03:31:25:13 TO BOUNCE OFF THE BOTTOM  
AND BACK TO THE DEVICE.

310 03:31:25:15 03:31:27:28 BY CONVERTING ECHO TIME  
INTO WATER DEPTH,

311 03:31:28:00 03:31:30:27 ECHO SOUNDING DEVICES DRAW  
A 2-DIMENSIONAL PROFILE

312 03:31:30:29 03:31:33:21 OF THE OCEAN FLOOR  
BENEATH THE RESEARCH VESSEL.

313 03:31:33:23 03:31:35:06 IN RECENT YEARS, HOWEVER,

314 03:31:35:08 03:31:36:21 MARINE GEOLOGIST  
HAVE EMPLOYED

315 03:31:36:23 03:31:38:13 MORE SOPHISTICATED

316 03:31:38:15 ACOUSTICAL TECHNIQUES  
 03:31:41:13 TO MAP THE TOPOGRAPHY  
 OF THE SEA FLOOR.  
 317 03:31:41:15 03:31:43:12 THESE ROBOTICALLY CONTROLLED  
 IMAGING DEVICES  
 318 03:31:43:14 03:31:45:29 CAN MAP AND AREA  
 OF THE OCEAN FLOOR  
 319 03:31:46:01 03:31:48:29 TENS OF KILOMETERS WIDE  
 IN A SINGLE PASS.  
 320 03:31:49:01 03:31:51:14 THIS 3-DIMENSIONAL VIEW  
 OF THE OCEAN BOTTOM  
 321 03:31:51:16 03:31:53:28 CAN BE CLEARER,  
 MORE DETAILED,  
 322 03:31:54:00 03:31:56:28 AND EVEN MORE VALUABLE  
 THAN THE OCEAN FLOOR VIEW  
 323 03:31:57:00 03:31:59:13 FROM THE WINDOW  
 OF A RESEARCH SUBMERSIBLE.  
 324 03:32:01:03 03:32:03:27 *ONE SUCH IMAGING DEVICE  
 IS CURRENTLY BEING USED*  
 325 03:32:03:29 03:32:05:29 *TO MAP  
 THE TERRITORIAL WATERS*  
 326 03:32:06:01 03:32:07:10 *OF THE UNITED STATES.*  
 327 03:32:09:13 03:32:11:11 *IN 1983,  
 THE FEDERAL GOVERNMENT*  
 328 03:32:11:13 03:32:14:11 *EXPANDED THIS REGION  
 TO INCLUDE ALL TERRAIN*  
 329 03:32:14:13 03:32:17:10 *WITHIN 200 MILES  
 OF AMERICAN SHORES.*  
 330 03:32:18:29 03:32:21:26 *THE U.S. GEOLOGICAL SURVEY  
 WAS ASSIGNED THE TASK*  
 331 03:32:21:28 03:32:24:12 *OF MAPPING THIS ENORMOUS  
 NEW ACQUISITION*  
 332 03:32:24:14 03:32:27:11 *FOR POSSIBLE FUTURE  
 DEVELOPMENT OF RESOURCES.*  
 333 03:32:27:13 03:32:29:26 *AT THE CORE OF THIS EFFORT*  
 334 03:32:29:28 03:32:32:10 *IS A SOPHISTICATED  
 ECHO SOUNDING TECHNOLOGY*  
 335 03:32:32:12 03:32:33:25 *CALLED "GLORIA."*  
 336 03:32:35:12 03:32:38:10 *GLORIA ENABLES BROAD AREAS  
 OF THE SEA FLOOR*  
 337 03:32:38:12 03:32:41:27 *ON EITHER SIDE OF THE SHIP  
 TO QUICKLY BE SCANNED,*  
 338 03:32:41:29 03:32:43:12 *UNLIKE TRADITIONAL SONAR,*  
 339 03:32:43:14 03:32:46:11 *WHICH ONLY PROVIDES  
 A PROFILE OF THE SEA FLOOR*  
 340 03:32:46:13 03:32:47:25 *DIRECTLY BENEATH THE SHIP.*  
 341 03:32:52:13 03:32:55:12 *GLORIA ITSELF  
 IS TOWED BEHIND THE SHIP,*  
 342 03:32:55:14 03:32:57:27 *TRAILING 200 METERS AWAY,*  
 343 03:32:57:29 03:32:59:28 *SOME 50 METERS  
 BENEATH THE SURFACE.*  
 344 03:33:02:26 03:33:05:11 *GLORIA CHANGED  
 OUR IMPRESSION  
 OF THE SEA FLOOR*  
 345 03:33:05:13 03:33:09:25 *BY AT ONE TIME  
 LETTING US VIEW*

346 03:33:09:27 THE ENTIRE SEA FLOOR  
 03:33:12:24 RATHER THAN VIEWING  
 SMALL PATCHES  
 347 03:33:12:26 BENEATH THE SHIP,  
 03:33:15:10 MANY, MANY TRACKS  
 GOING EVERY WHICH WAY  
 348 03:33:15:12 03:33:17:25 AND TRYING TO INTERPOLATE  
 BETWEEN THOSE TRACKS.  
 349 03:33:17:27 03:33:20:10 WITH GLORIA, WE CAN SEE  
 THE ENTIRE SURFACE--  
 350 03:33:20:12 03:33:22:09 WHERE THE SEA MOUNTS ARE,  
 351 03:33:22:11 03:33:25:08 WHERE THE CHANNELS ARE,  
 WHERE THE MEANDERS ARE,  
 352 03:33:25:10 03:33:27:09 WHERE THE CANYONS ARE,  
 THE GULLIES.  
 353 03:33:27:11 03:33:29:24 WE KNOW THE LOCATIONS  
 OF ALL THESE FEATURES  
 354 03:33:29:26 03:33:31:25 DOWN TO  
 VERY SMALL SCALE FEATURES.  
 355 03:33:31:27 03:33:34:19 IN THAT RESPECT, GLORIA  
 WAS A COMPLETE REVELATION.  
 356 03:33:36:00 03:33:38:24 TO ACCURATELY MAP  
 AN AREA OF OCEAN FLOOR  
 357 03:33:38:26 03:33:40:24 USING GLORIA TECHNOLOGY  
 358 03:33:40:26 03:33:43:09 REQUIRES VERY PRECISE  
 NAVIGATION.  
 359 03:33:43:11 03:33:46:08 THE LONGITUDES  
 AND LATITUDES  
 OF SPECIFIC SITES  
 360 03:33:46:10 03:33:48:10 ARE DETERMINED  
 WITH THE ASSISTANCE  
 361 03:33:48:12 03:33:49:25 OF EARTH-ORBITING  
 SATELLITES  
 362 03:33:49:27 03:33:52:24 IN COMMUNICATION  
 WITH THE RESEARCH VESSEL.  
 363 03:33:52:26 03:33:56:09 THIS TECHNIQUE  
 IS TERMED G.P.S.--  
 364 03:33:56:11 03:33:58:01 THE GLOBAL  
 POSITIONING SYSTEM.  
 365 03:33:59:15 03:34:02:09 NAVIGATION IS  
 THE MOST IMPORTANT DATA  
 WE COLLECT.  
 366 03:34:02:11 03:34:04:24 IF WE CAN'T  
 LOCATE THE IMAGE  
 367 03:34:04:26 03:34:06:10 OR A BIT OF IT  
 368 03:34:06:12 03:34:09:08 EXACTLY WHERE IT IS  
 ON THE SEA FLOOR,  
 369 03:34:09:10 03:34:11:08 THEN WE HAVEN'T  
 DONE OUR JOB.  
 370 03:34:11:10 03:34:13:08 SOMEONE MUST BE  
 ABLE TO RETURN,  
 371 03:34:13:10 03:34:15:22 AFTER IDENTIFYING SOMETHING  
 ON THE GLORIA MOSAIC,  
 372 03:34:15:24 03:34:17:22 RETURN TO THAT LATITUDE  
 AND LONGITUDE  
 373 03:34:17:24 03:34:20:07 AND FIND THAT IMAGE

374 03:34:20:09 03:34:21:22 ON THE SEA FLOOR,  
 SO WE USE  
 GLOBAL POSITIONING.  
 375 03:34:21:24 03:34:23:08 WE USE G.P.S. NAVIGATION.  
 376 03:34:23:10 03:34:25:22 IT'S WHAT WE PAY  
 MORE ATTENTION TO  
 377 03:34:25:24 03:34:28:08 ONBOARD THE SHIP  
 AND AFTER THE CRUISE  
 378 03:34:28:10 03:34:29:22 THAN ANYTHING ELSE.  
 379 03:34:29:24 03:34:32:06 IT'S THE CORNERSTONE  
 FOR EVERYTHING WE DO.  
 380 03:34:33:09 03:34:34:18 *AT THIS STAGE, HOWEVER,*  
 381 03:34:34:20 03:34:36:27 *THERE'S STILL NO IMAGE*  
*TO LOOK AT.*  
 382 03:34:36:29 03:34:38:22 *THE GLORIA DATA EXISTS*  
 383 03:34:38:24 03:34:42:09 *ONLY AS DIGITIZED BITS OF*  
*INFORMATION IN A COMPUTER,*  
 384 03:34:42:11 03:34:45:08 *WHICH IS PROCESSED AND*  
*ENHANCED TO CREATE IMAGES*  
 385 03:34:45:10 03:34:48:06 *SHOWING THE TOPOGRAPHY*  
*OF THE SEA FLOOR.*  
 386 03:34:49:26 03:34:52:07 *ULTIMATELY, OTHER*  
*VALUABLE INFORMATION*  
 387 03:34:52:09 03:34:54:07 *WILL COME FROM GLORIA WORK.*  
 388 03:34:54:09 03:34:56:08 *DEPTHS MAY BE*  
*ACCURATELY DETERMINED*  
 389 03:34:56:10 03:34:59:23 *FOR THE LOCATIONS FAR AWAY*  
*FROM THE RESEARCH VESSEL.*  
 390 03:34:59:25 03:35:01:08 *AND USING CHARACTERISTICS*  
 391 03:35:01:10 03:35:03:07 *OF REFLECTED*  
*SEISMIC ENERGY,*  
 392 03:35:03:09 03:35:05:21 *IT MAY EVEN BE POSSIBLE*  
*TO DETERMINE*  
 393 03:35:05:23 03:35:09:04 *THE TYPE OF MATERIAL*  
*MAKING UP THE SEA BED.*  
 394 03:35:11:22 03:35:14:05 *THE INDIVIDUAL IMAGES*  
*ARE PIECED TOGETHER*  
 395 03:35:14:07 03:35:18:20 *TO CREATE A LARGE MOSAIC VIEW*  
*OF THE SEA FLOOR.*  
 396 03:35:18:22 03:35:21:20 *ON AN OVERLAY PLACED*  
*ACROSS THE MOSAIC,*  
 397 03:35:21:22 03:35:24:05 *THE GEOLOGISTS TRACE*  
*THE IMPORTANT FEATURES*  
 398 03:35:24:07 03:35:27:04 *WHICH WILL ASSIST THEM*  
*IN MAKING A FINAL MAP.*  
 399 03:35:27:06 03:35:29:05 *THIS OVERLAY*  
*WILL ALSO HELP*  
 400 03:35:29:07 03:35:30:20 *IN DESCRIBING THE GEOLOGY*  
 401 03:35:30:22 03:35:34:13 *OF THIS NEWLY EXPLORED*  
*UNDERSEA TERRAIN.*  
 402 03:35:34:15 03:35:38:05 *THE ATLAS COMPILED FROM*  
*GLORIA'S MAPS AND IMAGES*  
 403 03:35:38:07 03:35:41:04 *IS EXPECTED TO HAVE*  
*MANY APPLICATIONS.*  
 404 03:35:42:09 03:35:44:05 *THE PEOPLE INTERESTED*  
*IN GLORIA DATA*

405 03:35:44:07 03:35:46:05 VARY FROM  
 OIL COMPANY GEOLOGISTS  
 406 03:35:46:07 03:35:48:21 THAT WANT TO KNOW  
 WHERE FEATURES ARE,  
 407 03:35:48:23 03:35:51:21 THE GEOMETRY  
 OF CERTAIN FEATURES,  
 WHICH WE CAN PROVIDE.  
 408 03:35:51:23 03:35:53:20 ACADEMIC SCIENTISTS  
 WANT TO KNOW  
 409 03:35:53:22 03:35:55:20 POSSIBLY AN AREA  
 THEY'RE INTERESTED IN.  
 410 03:35:55:22 03:35:57:04 IF WE IMAGED THAT AREA,  
 411 03:35:57:06 03:36:00:19 THEY KNOW WHERE TO FOCUS  
 ALL THEIR ENERGY AND MONEY  
 412 03:36:00:21 03:36:03:19 TO LOOK AT THE PROCESS  
 THEY'RE INTERESTED IN.  
 413 03:36:03:21 03:36:07:24 THE MILITARY I'M CERTAIN  
 IS INTERESTED IN  
 THE GLORIA DATA.  
 414 03:36:07:26 03:36:09:19 IT'S LIKE ANY BASE MAP.  
 415 03:36:09:21 03:36:12:04 IT'S A RECONNAISSANCE  
 OF THE SEA FLOOR.  
 416 03:36:12:06 03:36:13:19 IT PROVIDES THE BASIS  
 417 03:36:13:21 03:36:16:03 FOR BEGINNING TO UNDERSTAND  
 EVERYTHING THAT'S THERE.  
 418 03:36:18:19 03:36:21:02 *SOME RESEARCHERS*  
*ARE TRYING TO UNDERSTAND*  
 419 03:36:21:04 03:36:23:03 *WHERE VALUABLE*  
*GEOLOGICAL RESOURCES*  
 420 03:36:23:05 03:36:25:19 *ARE LOCATED*  
*ON THE SEA FLOOR.*  
 421 03:36:25:21 03:36:28:03 *IN A WORLD OF DIMINISHING*  
*RAW MATERIALS,*  
 422 03:36:28:05 03:36:30:04 *THE HOPE OF EXPLOITING*  
*THE OCEANS*  
 423 03:36:30:06 03:36:31:18 *FOR THEIR RESOURCES*  
 424 03:36:31:20 03:36:34:15 *HAS PERSISTED FOR DECADES.*  
 425 03:36:34:17 03:36:34:17 *AT PRESENT, THE ONLY*  
*GEOLOGIC RESOURCES*  
 426 03:37:00:00 03:37:02:04 *ON THE DEEP SEA FLOOR,*  
 427 03:37:02:06 03:37:04:18 *NODULES OF VALUABLE*  
*MANGANESE ORE*  
 428 03:37:04:20 03:37:06:17 *ARE SCATTERED*  
*BY THE MILLIONS.*  
 429 03:37:07:20 03:37:09:02 MANGANESE NODULES  
 430 03:37:09:04 03:37:11:19 ARE NOT COMPOSED  
 PURELY OF MANGANESE.  
 431 03:37:11:21 03:37:14:04 ONLY ABOUT 20%  
 OF A NODULE  
 432 03:37:14:06 03:37:15:10 CONTAINS MANGANESE.  
 433 03:37:15:12 03:37:18:18 ANOTHER 15% OR SO  
 MAY CONTAIN IRON  
 434 03:37:18:20 03:37:21:03 WITH TRACES  
 OF COBALT, NICKEL,  
 AND OTHER METALS,  
 435 03:37:21:05 03:37:23:03 BUT MOST OF THE NODULES

436 03:37:23:05 03:37:24:18 ARE MADE UP OF  
CALCIUM CARBONATE  
437 03:37:24:20 03:37:26:23 AND VOLCANIC FRAGMENTS.  
438 03:37:26:25 03:37:29:04 WHERE THE MANGANESE  
COMES FROM  
439 03:37:29:06 03:37:33:19 HAS BEEN  
A MYSTERY PROBLEM  
FOR SCIENCE.  
440 03:37:33:21 03:37:35:03 TWO POSSIBILITIES ARE  
441 03:37:35:05 03:37:37:18 THAT THE MANGANESE  
IS EXTRACTED  
442 03:37:37:20 03:37:40:03 FROM WATERS WASHING OFF  
THE CONTINENTS,  
443 03:37:40:05 03:37:41:18 OR FROM EXHALATIONS  
444 03:37:41:20 03:37:43:03 THROUGH UNDERSEA  
HOT SPRINGS  
445 03:37:43:05 03:37:45:04 ON THE MID-OCEAN  
RIDGES.  
446 03:37:45:06 03:37:48:19 THE MID-OCEAN RIDGE  
ORIGIN IS FAVORED,  
447 03:37:48:21 03:37:50:04 BUT HOW THE MANGANESE  
448 03:37:50:06 03:37:53:03 IS TRANSFERRED  
THROUGH THE WATER  
449 03:37:53:05 03:37:55:17 TO VERY SLOWLY  
ACCUMULATE AS  
THESE NODULES  
450 03:37:55:19 03:37:57:03 NUCLEATING  
ON THE SEA FLOOR  
451 03:37:57:05 03:37:59:17 IS, IN DETAIL, UNKNOWN.  
452 03:38:03:06 03:38:04:18 *BUT THE TECHNOLOGY REQUIRED*  
453 03:38:04:20 03:38:06:16 *TO HARVEST*  
*THESE UNDERSEA RESOURCES*  
454 03:38:06:18 03:38:08:08 *IS FORMIDABLE.*  
455 03:38:08:10 03:38:11:01 *AND, AS WITH OFF-SHORE*  
*OIL DRILLING,*  
456 03:38:11:03 03:38:13:23 *THERE ARE SERIOUS*  
*ENVIRONMENTAL CONCERNS.*  
457 03:38:13:25 03:38:15:16 COMPANIES  
HAVE EXPERIMENTED  
458 03:38:15:18 03:38:19:08 WITH DREDGING  
THE OCEAN BOTTOM  
FOR MANGANESE NODULES  
459 03:38:19:10 03:38:22:02 USING GIANT  
SUCTION DEVICES.  
460 03:38:22:04 03:38:24:01 THIS HAS BEEN  
SUCCESSFUL ENOUGH  
461 03:38:24:03 03:38:26:02 TO EXCITE SOME  
COMMERCIAL INTEREST.  
462 03:38:26:04 03:38:28:01 FOR EXAMPLE,  
IN HAWAIIAN WATERS,  
463 03:38:28:03 03:38:32:01 HARVESTING ORES  
OFF THE MID-OCEAN RIDGE  
464 03:38:32:03 03:38:34:00 PROBABLY REQUIRES  
MORE CARE  
465 03:38:34:02 03:38:37:02 AND IS  
PROHIBITIVELY EXPENSIVE.



466 03:38:37:04 03:38:39:02 THEN THERE ARE  
ENVIRONMENTAL CONCERNS.  
467 03:38:39:04 03:38:41:17 FOR EXAMPLE,  
IF A MINING OPERATION  
468 03:38:41:19 03:38:44:16 WERE TO EVER START  
ON A MID-OCEAN RIDGE,  
469 03:38:44:18 03:38:46:16 IT COULDN'T HELP  
BUT TO DESTROY  
470 03:38:46:18 03:38:48:16 THE FRAGILE AND  
SPECTACULAR ECOSYSTEM  
471 03:38:48:18 03:38:51:20 WHICH MAKES  
ITS HABITAT THERE.  
472 03:38:51:22 03:38:54:17 *IN ADDITION TO*  
*ITS ECONOMIC APPLICATIONS,*  
473 03:38:54:19 03:38:57:17 *THE USE OF SONAR TECHNOLOGY*  
*HAS HELPED SCIENTISTS*  
474 03:38:57:19 03:38:59:01 *ANSWER SOME*  
*PROFOUND QUESTIONS*  
475 03:38:59:03 03:39:02:15 *ABOUT THE NATURE AND*  
*GROWTH OF THE SEA FLOOR.*  
476 03:39:02:17 03:39:04:01 *FOR EXAMPLE, MAPPING SHOWS*  
477 03:39:04:03 03:39:06:29 *HOW THE POSITIONS*  
*OF MID-OCEAN RIDGES*  
478 03:39:07:01 03:39:08:14 *CHANGE OVER TIME,*  
479 03:39:08:16 03:39:10:14 *AND HOW THE STRUCTURES*  
*OF RIDGES*  
480 03:39:10:16 03:39:13:26 *VARY WITH DIFFERENT RATES*  
*OF SPREADING.*  
481 03:39:13:28 03:39:16:15 *DESPITE THE USEFULNESS*  
*OF INDIRECT MEANS*  
482 03:39:16:17 03:39:18:22 *OF STUDYING*  
*THE SEA FLOOR,*  
483 03:39:18:24 03:39:22:07 *MORE DIRECT OBSERVATIONS*  
*MUST SOMETIMES BE MADE.*  
484 03:39:22:09 03:39:23:29 *SAMPLES ARE DREDGED*  
485 03:39:24:01 03:39:26:14 *TO EXAMINE THE MAKEUP*  
*OF THE SEA BED,*  
486 03:39:26:16 03:39:29:15 *AND CAMERAS OPERATED*  
*BY REMOTE CONTROL*  
487 03:39:29:17 03:39:31:24 *ARE SENT TO*  
*THE BOTTOM OF THE OCEAN.*  
488 03:39:33:01 03:39:35:29 *TRYING TO TAKE A PICTURE*  
*IS REALLY HARD*  
489 03:39:36:01 03:39:37:14 *BECAUSE*  
*IT'S PITCH BLACK.*  
490 03:39:37:16 03:39:39:29 *YOU HAVE TO BRING*  
*YOUR OWN LIGHTING.*  
491 03:39:40:01 03:39:42:01 *AND TURN IT ON AND OFF.*  
492 03:39:42:03 03:39:45:00 *A GLAMOUROUS WAY*  
*OF STUDYING THE OCEAN FLOOR*  
493 03:39:45:02 03:39:47:15 *IS TO GO*  
*IN A SMALL SUBMARINE.*  
494 03:39:47:17 03:39:49:29 *I'VE TAKEN 12 DIVES*  
*TO THE DEEP OCEAN.*  
495 03:39:50:01 03:39:51:24 *IT'S LIKE GOING TO MARS.*  
496 03:39:51:26 03:39:53:14 *BUT THAT'S*

497 03:39:53:16 03:39:56:13 IT'S LIKE DOING GEOLOGY  
 IN A JEEP AT MIDNIGHT  
 498 03:39:56:15 03:39:58:28 WITH DIRTY WINDOWS  
 WITH YOUR HEADLIGHTS  
 499 03:39:59:00 03:40:03:00 WITHOUT EVER BEING ABLE  
 TO GET OUT OF THE JEEP.  
 500 03:40:03:02 03:40:05:01 IT'S VERY FRUSTRATING  
 BUSINESS.  
 501 03:40:05:03 03:40:07:13 IT'S LUCKY FOR US  
 THAT THE OCEANIC CRUST  
 502 03:40:07:15 03:40:09:13 AND THE PROCESSES  
 IN THE OCEAN  
 503 03:40:09:15 03:40:11:27 ARE RELATIVELY SIMPLE  
 COMPARED TO THE LAND,  
 504 03:40:11:29 03:40:14:24 OR WE'D NEVER  
 FIGURE IT OUT AT ALL.  
 505 03:40:16:01 03:40:17:26 *BUT EVEN WITH*  
*THESE LIMITATIONS,*  
 506 03:40:17:28 03:40:19:28 *SUBMERSIBLES*  
*AND REMOTE CAMERAS*  
 507 03:40:20:00 03:40:21:29 *HAVE PROVIDED*  
*A WEALTH OF INFORMATION*  
 508 03:40:22:01 03:40:23:28 *ABOUT THE SEA FLOOR.*  
 509 03:40:24:00 03:40:27:20 *UNIQUE LIFE FORMS THRIVE*  
*IN THE OCEAN ENVIRONMENT,*  
 510 03:40:27:22 03:40:29:12 *FROM THE DEEP SEA FLOOR*  
 511 03:40:29:14 03:40:31:11 *TO THE SHALLOW*  
*CONTINENTAL SHELVES.*  
 512 03:40:32:29 03:40:35:17 *MANY ORGANISMS LIVE*  
*SUSPENDED IN THE WATER*  
 513 03:40:35:19 03:40:39:27 *THROUGHOUT MOST*  
*OR ALL OF THEIR LIVES.*  
 514 03:40:39:29 03:40:42:13 *OTHERS INHABIT*  
*THE OCEAN FLOOR,*  
 515 03:40:42:15 03:40:44:17 *BURROWING INTO*  
*ITS SOFT SEDIMENT*  
 516 03:40:44:19 03:40:48:08 *OR SCURRYING*  
*ACROSS THE SILTY BOTTOM.*  
 517 03:40:48:10 03:40:53:00 *LIFE HAS BEEN FOUND*  
*IN MANY UNEXPECTED PLACES.*  
 518 03:40:53:02 03:40:55:27 *ONE OF THE MOST*  
*SPECTACULAR DISCOVERIES*  
 519 03:40:55:29 03:40:58:12 *OCCURRED WHEN SUBMERSIBLES*  
*FIRST EXPLORED*  
 520 03:40:58:14 03:41:02:11 *THE ACTIVE VOLCANIC REGION*  
*ATOP THE MID-OCEAN RIDGES.*  
 521 03:41:03:16 03:41:05:25 THE MOST EXCITING ADVENTURE  
 WE'VE HAD  
 522 03:41:05:27 03:41:07:11 IN THE SUBMARINE ALVIN  
 523 03:41:07:13 03:41:11:03 WAS THE DISCOVERY  
 AND EXPLORATION  
 OF THE HOT VENTS.  
 524 03:41:11:05 03:41:14:04 THEY RANGE FROM  
 JUST A LITTLE BIT WARM  
 525 03:41:14:06 03:41:18:11 TO OUTRAGEOUSLY HOT--

526 03:41:18:13 350 DEGREES CENTIGRADE.  
 03:41:21:10 ORDINARILY,  
 WATER WOULD BOIL  
 527 03:41:21:12 AT 100 DEGREES,  
 03:41:23:16 BUT THE PRESSURE'S  
 SO HIGH THERE  
 528 03:41:23:18 03:41:25:01 THAT IT DOESN'T BOIL,  
 529 03:41:25:03 03:41:27:25 BUT IT COMES OUT  
 EXTREMELY HOT.  
 530 03:41:27:27 03:41:30:11 WHEN IT'S  
 A LITTLE BIT COOLER,  
 531 03:41:30:13 03:41:32:25 THERE ARE STRANGE ANIMALS  
 THAT LIVE THERE  
 532 03:41:32:27 03:41:34:26 THAT HAVEN'T  
 BEEN SEEN ANYWHERE ELSE,  
 533 03:41:34:28 03:41:38:09 INCLUDING LONG TUBE WORMS  
 WITH BRIGHT RED FLESH.  
 534 03:41:38:11 03:41:41:10 THERE ARE  
 CRABS RUNNING AROUND  
 EATING EVERYTHING ELSE.  
 535 03:41:41:12 03:41:43:24 GIANT CLAMS LIKE THIS  
 WITH RED FLESH.  
 536 03:41:43:26 03:41:46:26 ALL THOSE ANIMALS ARE LIVING  
 ON THE CHEMICAL ENERGY  
 537 03:41:46:28 03:41:49:11 THAT'S IN THE WATER  
 OF THE VENTS.  
 538 03:41:49:13 03:41:52:25 THEY HAVE  
 SPECIAL BACTERIA  
 THAT USE HYDROGEN SULFIDE--  
 539 03:41:52:27 03:41:56:07 GAS THAT POISONS US  
 IF WE GET A TINY WHIFF.  
 540 03:41:56:09 03:41:59:24 THEY'RE USING IT  
 FOR ITS CHEMICAL ENERGY  
 541 03:41:59:26 03:42:02:11 AND PASSING THAT  
 DOWN THE FOOD CHAIN.  
 542 03:42:02:13 03:42:06:24 IT'S A TOTALLY DIFFERENT  
 ECOLOGICAL SITUATION  
 THAN WE'RE USED TO.  
 543 03:42:06:26 03:42:09:08 IT'S SO EXCITING  
 TO SEE A LIVING THING  
 544 03:42:09:10 03:42:11:09 IN SUCH AN ALIEN  
 ENVIRONMENT.  
 545 03:42:11:11 03:42:13:08 THEY'RE REALLY BIZARRE.  
 546 03:42:13:10 03:42:14:07 REALLY BIZARRE.  
 547 03:42:15:24 03:42:18:23 *THESE WEIRD AND WONDROUS*  
*DENIZENS OF THE DEEP*  
 548 03:42:18:25 03:42:20:22 *ARE THE ONLY EXAMPLES*  
*OF LIFE*  
 549 03:42:20:24 03:42:23:24 *WHICH GET THEIR SUPPLY*  
*OF ENERGY AND WARMTH*  
 550 03:42:23:26 03:42:26:09 *FROM THE INTERIOR*  
*OF THE EARTH ITSELF.*  
 551 03:42:26:11 03:42:29:08 *THEY LIVE KILOMETERS*  
*BENEATH THE OCEAN SURFACE*  
 552 03:42:29:10 03:42:33:22 *IN A WORLD AS ALIEN AS ANY*  
*ENCOUNTERED IN OUTER SPACE.*

553 03:42:37:26 03:42:40:24 THE VAST COMMITMENT  
OF PEOPLE AND TECHNOLOGY

554 03:42:40:26 03:42:43:08 FOCUSED ON UNDERSTANDING  
THE SEA FLOOR

555 03:42:43:10 03:42:45:23 IS DRIVEN BY TWO FUNDAMENTAL  
HUMAN MOTIVES.

556 03:42:45:25 03:42:48:08 ON ONE HAND  
IS OUR CURIOSITY

557 03:42:48:10 03:42:49:23 ABOUT THE FUNCTIONING  
OF NATURE.

558 03:42:49:25 03:42:51:23 THE GEOLOGY  
OF THE SEA FLOOR

559 03:42:51:25 03:42:54:09 HOLDS THE ANSWERS  
TO MANY VEXING QUESTIONS

560 03:42:54:11 03:42:56:09 ABOUT THE EARTH  
AND ITS HISTORY.

561 03:42:56:11 03:42:59:09 WHAT IS THE ORIGIN  
OF THE ATMOSPHERE  
AND HYDROSPHERE?

562 03:42:59:11 03:43:02:08 HOW AND WHY DO  
THE TECTONIC PLATES MOVE?

563 03:43:02:10 03:43:04:23 AND HOW ARE THE EARTH'S  
VAST DEPOSITS

564 03:43:04:25 03:43:08:20 OF VALUABLE RESOURCES LIKE  
METALLIC ORES AND PETROLEUM

565 03:43:08:22 03:43:09:24 ACTUALLY FORMED?

566 03:43:09:26 03:43:12:06 THE GEOLOGY  
OF THE SEA FLOOR

567 03:43:12:08 03:43:14:22 HOLDS THE ANSWERS  
TO THESE QUESTIONS

568 03:43:14:24 03:43:17:22 AND PROVIDES UNEXPECTED  
INTELLECTUAL DIVIDENDS

569 03:43:17:24 03:43:19:22 SUCH AS  
THE FANTASTIC DISCOVERY

570 03:43:19:24 03:43:21:21 OF A SELF-CONTAINED ECOLOGY

571 03:43:21:23 03:43:24:17 ASSOCIATED WITH DEEP SEA  
HYDROTHERMAL VENTS.

572 03:43:24:19 03:43:27:06 ON THE OTHER HAND,  
WE ARE COMPELLED BY

573 03:43:27:08 03:43:30:05 THE ECONOMIC, POLITICAL,  
AND ENVIRONMENTAL REALITIES

574 03:43:30:07 03:43:33:21 BROUGHT ON  
BY OUR INDUSTRIAL,  
GLOBAL CIVILIZATION.

575 03:43:33:23 03:43:36:21 IT'S HERE THAT  
OUR SCIENTIFIC CURIOSITY

576 03:43:36:23 03:43:39:06 CONVERGES WITH  
MORE IMMEDIATE HUMAN NEEDS.

577 03:43:39:08 03:43:41:20 FOR EXAMPLE, UNDERSTANDING  
THE GEOLOGIC ORIGIN

578 03:43:41:22 03:43:44:06 OF OIL AND GAS  
AND METAL ORES

579 03:43:44:08 03:43:47:22 IMPROVES OUR ABILITY TO FIND  
AND DEVELOP THESE RESOURCES

580 03:43:47:24 03:43:49:07 IN MARINE ENVIRONMENTS.

581 03:43:49:09 03:43:51:07 THIS ABILITY

582 03:43:51:09 03:43:53:21 AS OUR CONTINENTAL SUPPLIES  
 ARE DEPLETED.  
 583 03:43:53:23 03:43:56:21 THE SEA FLOOR ALSO PLAYS  
 A VITAL FUNCTION  
 584 03:43:56:23 03:43:58:06 IN DETERMINING  
 GLOBAL CLIMATE,  
 585 03:43:58:08 03:43:59:20 AND UNDERSTANDING  
 ITS FUNCTION  
 586 03:43:59:22 03:44:01:22 HELPS US TO BETTER ADDRESS  
 587 03:44:01:24 03:44:04:21 SUCH ENVIRONMENTAL PROBLEMS  
 AS THE GREENHOUSE EFFECT,  
 588 03:44:04:23 03:44:06:05 CHANGING GLOBAL CLIMATE,  
 589 03:44:06:07 03:44:07:22 AND RISING SEA LEVEL.  
 590 03:44:07:24 03:44:11:20 THE SEA FLOOR MAKES UP OVER  
 2/3 OF THE EARTH'S SURFACE,  
 591 03:44:11:22 03:44:14:19 AND UNTIL RECENTLY, ITS  
 VAST SUBMERGED LANDSCAPE  
 592 03:44:14:21 03:44:16:18 REMAINED VIRTUALLY UNKNOWN.  
 593 03:44:16:20 03:44:20:04 BUT NOW, AS WE BEGIN  
 TO KNOW AND UNDERSTAND  
 594 03:44:20:06 03:44:21:18 THIS STRANGE, DARK WORLD,  
 595 03:44:21:20 03:44:23:05 WE'RE LEARNING NEW FACTS  
 596 03:44:23:07 03:44:25:20 ABOUT THE WAY  
 OUR PLANET BEHAVES,  
 597 03:44:25:22 03:44:27:20 AND DISCOVERING  
 NEW OPPORTUNITIES  
 598 03:44:27:22 03:44:30:19 TO IMPROVE THE FUTURE  
 OF ALL HUMANKIND.  
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