Capulin Volcano National Monument

Ancillary Map Information Document

Produced to accompany the Geologic Resources Inventory Digital Geologic Data for Capulin Volcano National Monument

cavo_geology.pdf

Version: 8/3/2015
Geologic Resources Inventory Map Document for Capulin Volcano National Monument

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Geologic Resources Inventory Map Document

Capulin Volcano National Monument, New Mexico

Document to Accompany Digital Geologic-GIS Data

cavo_geology.pdf

Version: 8/3/2015

This document has been developed to accompany the digital geologic-GIS data developed by the Geologic Resources Inventory (GRI) program for Capulin Volcano National Monument, New Mexico (CAVO).

Attempts have been made to reproduce all aspects of the original source products, including the geologic units and their descriptions, geologic cross sections, the geologic report, references and all other pertinent images and information contained in the original publication.

National Park Service (NPS) Geologic Resources Inventory (GRI) Program staff have assembled the digital geologic-GIS data that accompanies this document.

For information about the status of GRI digital geologic-GIS data for a park contact:

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About the NPS Geologic Resources Inventory Program

Background

Recognizing the interrelationships between the physical (geology, air, and water) and biological (plants and animals) components of the Earth is vital to understanding, managing, and protecting natural resources. The Geologic Resources Inventory (GRI) helps make this connection by providing information on the role of geology and geologic resource management in parks.

Geologic resources for management consideration include both the processes that act upon the Earth and the features formed as a result of these processes. Geologic processes include: erosion and sedimentation; seismic, volcanic, and geothermal activity; glaciation, rockfalls, landslides, and shoreline change. Geologic features include mountains, canyons, natural arches and bridges, minerals, rocks, fossils, cave and karst systems, beaches, dunes, glaciers, volcanoes, and faults.

The Geologic Resources Inventory aims to raise awareness of geology and the role it plays in the environment, and to provide natural resource managers and staff, park planners, interpreters, researchers, and other NPS personnel with information that can help them make informed management decisions.

The GRI team, working closely with the Colorado State University (CSU) Department of Geosciences and a variety of other partners, provides more than 270 parks with a geologic scoping meeting, digital geologic-GIS map data, and a park-specific geologic report.

Products

Scoping Meetings: These park-specific meetings bring together local geologic experts and park staff to inventory and review available geologic data and discuss geologic resource management issues. A summary document is prepared for each meeting that identifies a plan to provide digital map data for the park.

Digital Geologic Maps: Digital geologic maps reproduce all aspects of traditional paper maps, including notes, legend, and cross sections. Bedrock, surficial, and special purpose maps such as coastal or geologic hazard maps may be used by the GRI to create digital Geographic Information Systems (GIS) data and meet park needs. These digital GIS data allow geologic information to be easily viewed and analyzed in conjunction with a wide range of other resource management information data.

For detailed information regarding GIS parameters such as data attribute field definitions, attribute field codes, value definitions, and rules that govern relationships found in the data, refer to the NPS Geology-GIS Data Model document available at: http://science.nature.nps.gov/im/inventory/geology/GeologyGISDataModel.cfm

Geologic Reports: Park-specific geologic reports identify geologic resource management issues as well as features and processes that are important to park ecosystems. In addition, these reports present a brief geologic history of the park and address specific properties of geologic units present in the park.

For a complete listing of Geologic Resource Inventory products and direct links to the download site visit the GRI publications webpage http://www.nature.nps.gov/geology/inventory/gre_publications.cfm

GRI geologic-GIS data is also available online at the NPS Data Store site https://irma.nps.gov/App/Reference/Search/. To find GRI data enter the search text "geology", "gri" and the park name for the
For more information about the Geologic Resources Inventory Program visit the GRI webpage: http://www.nature.nps.gov/geology/inventory, or contact:

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The Geologic Resources Inventory (GRI) program is funded by the National Park Service (NPS) Inventory and Monitoring (I&M) program. For more information on the Inventory and Monitoring (I&M) program visit: http://science.nature.nps.gov/im/index.cfm

For more information on this and other Inventory and Monitoring (I&M) Natural Resource inventories visit: http://science.nature.nps.gov/im/inventory/index.cfm
Volcanic Feature List

The volcanic features present in the GRI digital geologic-GIS data produced for Capulin Volcano National Monument, New Mexico (CAVO) are listed below. Units are simply listed in alphabetical order. The general sequence of feature extrusion and creation, 1st (oldest) through 5th (youngest) as presented by the source author, is also listed as well as presented in the GIS data in the Notes attribute field on a feature basis. Capulin is a basaltic trachyandesite according to Sayre and Ort (1999).

Volcanic Features

Features Mapped/Represented as Area (Polygon) Features
- Boca rampart
- Collapsed lava tube
- Lava
- Lava lake
- Levee
- Main cone
- Pooled lava flow
- Push-up
- Rafted cinder cones
- Spatter deposit
- Spatter flow
- Vent

Features Mapped/Represented as Line Features
- Lava cascades
- Lava ridges

Features Mapped/Represented as Point Features
- Cave
- Squeeze-up
- Tumulus
- Vent
Volcanic Feature Descriptions

Descriptions of all volcanic features are presented below. Feature descriptions were provided by Rebecca Richman based mostly on the park document, "Volcanology for Interpreters; Capulin Volcano National Monument" by Allyson Mathis, 1999.

Volcanic Area Features

Boca rampart

The Boca Rampart is a massive feature created by the accumulation of other features, particularly levee, and includes levees, lava lakes, and collapsed lava tubes. GRI Source Map ID 75447 (Capulin Volcano Geology Inventory)

** Mapped in the 2nd sequence.

Collapsed lava tube

Lava tubes form when the surface of a lava flow crusts over while lava continues to flow in the interior of the flow. When the lava supply is cut off at the source, or begins to flow elsewhere, a lava tube may drain downslope, leaving an empty conduit. If flow rate is fast enough, a flow may thermally erode into pre-existing or underlying lava flows. Collapsed lava tubes are recognized as linear depressions filled with rubble from the roof of the tube when it collapsed. GRI Source Map ID 75447 (Capulin Volcano Geology Inventory)

** Mapped in the 2nd sequence.

Lava

Lava flow. Basaltic trachyandesite according to Sayre and Ort (1999). GRI Source Map ID 75447 (Capulin Volcano Geology Inventory)

* In some areas lines were added to enclose an internal area in the GIS data, however, these areas shouldn't be used to infer the extent or limit of the lava flows.

** Mapped in the 2nd and 5th sequences.

Lava lake

A lake of molten lava in a volcanic crater or vent area, or depression, or a solidified lava lake. Lava lakes formed in the Boca at Capulin Volcano. GRI Source Map ID 75447 (Capulin Volcano Geology Inventory)

** Mapped in the 2nd sequence.

Levee

Levees are natural banks at the sides of a lava flow. They form from a chilled margin that channels the lava into a self-made channel. Levees may be left higher than the surface of a lava flow when flow rate decreases from an initially high rate. Levees may also form from overflow over a chilled margin or from collapse of a tube during eruption when the active flow carries away the fragments of
the tube roof. The Capulin Volcano road travels between levees near the picnic area. *GRI Source Map ID 75447 (Capulin Volcano Geology Inventory)*

** Mapped in the 2nd, 4th and 5th sequences.

**Main cone**

The cinder cone created around the central vent of the volcano. *GRI Source Map ID 75447 (Capulin Volcano Geology Inventory)*

** Mapped in the 1st sequence.

**Pooled lava flow**

Sayre and Ort identified a feature referred to as "pooled lava flow" on the eastern boundary of the park. Survey reveled a lava feature in the general area of their feature, but it is unclear if this feature was what they were referring to as "pooled lava flow". *GRI Source Map ID 75447 (Capulin Volcano Geology Inventory)*

** Mapped in the 3rd sequence.

**Push-up**

A hardened surface of a lava flow that has been pushed up and tilted by molten lava within a lava flow. *GRI Source Map ID 75447 (Capulin Volcano Geology Inventory)*

** Mapped in the 2nd sequence.

**Rafted cinder cones**

No description provided. *GRI Source Map ID 75447 (Capulin Volcano Geology Inventory)*

** Mapped in the 2nd sequence.

**Spatter deposit**

Areas around eruptive vents or cracks in the crust of a lava flow. Formed by the discharge of clots of lava that build piles of agglomerate or spatter. *GRI Source Map ID 75447 (Capulin Volcano Geology Inventory)*

** Mapped in the 2nd sequence.

**Spatter flow**

A lava flow that originates from an accumulation of spatter (very hot and fluid bombs) that was hot and plastic enough to allow flowage under the weight of gravity. There are spatter flows on the rim and in the boca of Capulin Volcano. *GRI Source Map ID 75447 (Capulin Volcano Geology Inventory)*

** Mapped in the 2nd sequence.
Vent
The opening at the Earth's surface through which volcanic materials is extruded. Also, the channel or conduit through which volcanic materials pass on the way to the surface. GRI Source Map ID 75447 (Capulin Volcano Geology Inventory)

** Mapped in the 1st and 2nd sequences.

Volcanic Line Features

Lava cascades
A chute through which lava moved over in a cascade as the lava flow passed over a cliff a steep section of its course. Lava cascades are found along the Boca walls at Capulin Volcano. GRI Source Map ID 75447 (Capulin Volcano Geology Inventory)

** Mapped in the 2nd sequence.

Lava ridges
This feature type includes features that were raised rocky ridges, similar to levee boundaries, but not creating a definable area of raise levees or spatter deposits. GRI Source Map ID 75447 (Capulin Volcano Geology Inventory)

** Mapped in the 2nd and 5th sequences.

Volcanic Point Features

Cave
A cave created by the flow of lava. GRI Source Map ID 75447 (Capulin Volcano Geology Inventory)

** Mapped in the 2nd sequence.

Squeeze-up
A small, bulbous, linear, or irregularly-shaped accumulation of lava formed by the extrusion of viscous lava through an opening in the solidified crust of a flow. (Some geologists restrict this term to linear features, and call the bulbous-shaped mounds “tumuli.”). GRI Source Map ID 75447 (Capulin Volcano Geology Inventory)

** Mapped in the 2nd, 4th and 5th sequences.

Tumulus
A small, dome-shaped mound on the surface of a lava flow. Tumuli result from buckling of the flow crust, aided by pressure of the underlying liquid lava, or by the extrusion of viscous lava through an opening in the solidified crust of a flow. Tumuli are best developed on flows on flat or gently sloping ground. GRI Source Map ID 75447 (Capulin Volcano Geology Inventory)

** Mapped in the 2nd, 4th and 5th sequences.
Vent

The opening at the Earth’s surface through which volcanic materials is extruded. Also, the channel or conduit through which volcanic materials pass on the way to the surface. GRI Source Map ID 75447 (Capulin Volcano Geology Inventory)

**Mapped in the 1st, 2nd, and 3rd sequences.**
GRI Source Map Citation

The GRI digital geologic-GIS maps for Capulin Volcano National Monument, New Mexico (CAVO) were compiled from the following source:

Richman, Rebecca, 2010, Digital Volcanic Geology of Capulin Volcano National Monument and Vicinity, New Mexico, National Park Service, U.S. Department of Interior, unpublished digital data, 1:24,000 scale (GRI Source Map ID 75447)

Richman's mapping utilized the following sources.


**See the Report section for how these sources were utilized.

Volcanic feature descriptions were derived based mostly on the park document, "Volcanology for Interpreters; Capulin Volcano National Monument" by Allyson Mathis, 1999.

Additional information pertaining to the source map (Richman, 2010) is also presented in the Source Map Information (MAP) table included with the GRI geology-GIS data.

Report

**Report on the Creation of a Geologic Inventory Map for Capulin Volcano National Monument**

Rebecca Richman
SCA Geology and Interpretation Intern
July 13th, 2010

Introduction

Capulin Volcano National Monument contains one of the best examples of an extinct cinder cone volcano in the United States. It is, therefore, important to have a good inventory of the geologic features of the park. To this end, data on the geologic features were collected during April-July 2010 with the purpose of creating a map and geodatabase that could be used in the construction of a Geologic Resource Inventory. This report includes the process by which the map and geodatabase were constructed, notes on accuracy in general and of particular features, a list and explanation of attributes collected for each feature, and a summary table of the features found within the park.
Process

Prior Geologic Survey:
From 1992 to 2002 Dr. William Sayre (formerly of College of Santa Fe, currently of New Mexico Highlands University) and Dr. Michael Ort (formerly of the College of Santa Fe, currently of Northern Arizona University) performed a study on the geology of Capulin Volcano. Based on their study, Dr. Sayre created shapefiles of geologic features using heads-up methods based on an unknown topology map with an unknown projection. These features did not correctly correspond to the Digital Orthophoto Quarter Quadrangle of SW Section of the Folsom, NM Quadrangle and so, in 2002, Dr. Sayre redigitized the lava flow, fissure vents (all fissure vents are outside of park boundaries), vents, and sample locations to correspond with the orthophoto. Thus two maps were produced from Sayre and Ort's work at Capulin, an uncorrected map with multiple features, and a corrected lava flow series map. A report for the NPS entitled “A geologic study of Capulin Volcano National Monument and surrounding areas” (1999), and an article for Park Science entitled “Capulin Volcano is Approximately 59,100 Years Old” (1995) were also produced.

Unfortunately, the map of Capulin's lava flows in the park brochure is based on Sayre and Ort’s original uncorrected map. This should be replaced with the redigitized map as soon as possible.

Current Geologic Survey:
The majority of data were collected in the field using a Trimble GeoExplorer Series 2008 Geo XT Series GPS data collector. Identification of features was based on Sayre and Ort's initial geologic map which identified the location and type of many features. Unfortunately, Sayre and Ort's map was created heads up on an unknown topology map with an unknown projection, so the features were inaccurately located and some small features were not included. However, it was useful as a rough guide to the type of geologic features of the park, helping with identification of feature type. A data dictionary was created for the purpose of mapping the geologic features, and field data collection took place mostly during May 2010. All data were collected in the projection UTM NAD 1983 N13. All areas within the park boundary were surveyed on foot except for the 2nd easternmost NW corner due to impassable terrain.

As data were collected in the field, the data were uploaded and differentially corrected using GPS Pathfinder then exported as ESRI shapefiles (Base Provider: CORS, ANGELFIRE_NM2004(P036), NEW MEXICO). The shapefiles were then uploading into ArcMap to monitor what features had been mapped. After field data collection was complete, the data were again differentially corrected in GPS Pathfinder and exported as ESRI shapefiles.

A geodatabase with point, line and polygon feature classes was created and populated with features mainly created by tracing the shapefiles created by the field data collection, although some features were either partially or completely drawn-heads up based on the USGS 7.5’ minute topographic map (Folsom Quadrangle), the digital orthophoto of the area, and/or Sayre and Orts lava flow series map. Another polygon feature class containing Sayre and Orts classification of lava flows is included in the geodatabase.

On occasion the GPS work conflicted with Sayre and Ort's lava flow data. Particularly, the outline of the boca is more detailed in the field collected polygon data set than in Sayre and Orts data set, and the easternmost levee overlaps with Sayre's and Orts's Main cone features. Sayre and Orts's lava flow data have not been modified to reflect the more precise data.
**Accuracy of Data**

Although Sayre's and Ort's data provided a great deal of information on the identification of geologic features, at times educated guesses were made in the identification of geologic features, as well as the precise locations of feature edges. It is, therefore, desirable that this map and geodatabase be checked by a geologist and GSI staff for accuracy. To this purpose, any questions as to the accuracy of a feature are recorded in the ACCURACY attribute, and further details may be found in the NOTES attribute as well as below in the notes on particular features.

**Notes on Particular Features:**

**Spatter and Spatter Covered Levees:** It was not always possible to distinguish between spatter deposit and spatter covered levees. As a rule, a feature was only classified as a levee if it was linear in shape, while more circular features were classified as spatter deposits.

**Boca Rampart:** The Boca Rampart is a massive feature created by the accumulation of other features, particularly levee, and includes levees, lava lakes, and collapsed lava tubes. It may be desirable in the future to divide the boca rampart into the levees of which it consists. However, it is unclear at the present how best to do this.

**Lava Tubes:** The area depicted here shows the area of lava tube collapse, not the actual location or size of the lava tubes. These were hard to define using the GPS device due to rough terrain and were mostly created heads up based on what GPS data could be collected and the orthophoto.

**Lava Ridges:** This feature type includes features that were raised rocky ridges, similar to levee boundaries, but not creating a definable area of raise levees or spatter deposits.

**Lava Cascades:** These features were created heads-up defined by the gaps in the levee, rampart, and lava ridges.

**Pooled Lava Flow:** Sayre and Ort identified a feature referred to as "pooled lava flow" on the eastern boundary of the park. Survey revealed a lava feature in the general area of their feature, but it is unclear if this feature was what they were referring to as "pooled lava flow." However, given the lack of any other information, this feature is referred to as "pooled lava flow" in the geodatabase.

**Cinder Flow:** Sayre and Ort identified two features referred to as "cinder flow" on the side of the main cone immediately east of the boca vents. It was not clear how to identify these features, and so they were not mapped.

**Strike and Dip, Direction of Flow:** Strike and dip and direction of lava flow were collected by Sayre and Ort in their original database. However, as the locations of the points are uncertain, they are not included in the final geodatabase. The data is available in Sayre and Ort’s original file and in a geodatabase constructed to contain Sayre and Ort’s data as part of this project. (cavogeoSayreOrt1999.mdb)

**Attributes of Features**

The following applies to the source data geodatabase files provided to the GRI program by the source
map/data author Rebecca Richman. FLOCATION, METHOD, ACCURACY, and APPROX_SIZE were added to the GRI digital data attribution, whereas other fields were incorporated into existing GRI Geology-GIS Geodatabase Data Model attribute fields.

The first two items in the attribute table are the default attribute information in the ArcView shapefile format, as are the SHAPE_Length and SHAPE_Area.

The rest of the feature attributes were created with a final GRI geodatabase in mind, and the GRI database model was loosely used, although some attributes were not applicable to this database, or the meaning of the attribute was unclear, and therefore those attributes were not collected. The attributes of METHOD, ACCURACY, and APPROX_SIZE were added specifically for this database.

**Attributes:**

**GLG_SYSTEM:** This attribute is based on the GRI data model and identifies the type of feature.

  CZign = Cenozoic igneous body (for polygons)  
  CZvlf = Cenozoic volcanic line features (for lines)  
  CZvpf = Cenozoic volcanic point features (for points)

**FTYPE:** Feature type (i.e. vent, levee, lava lake) I used this attribute as the subtype attribute.

**FLOCATION:** The unit of Sayre and Ort's Lava flow map in which the feature is found (i.e. main cone, boca, first lava flow).

**METHOD:**

  GPS: The feature was either completely or mostly mapped using a GPS device.  
  Traced: The feature was drawn in ArcGIS using a combination of GPS data, the orthophoto, topology map, and/or other features.  
  Based on Sayre and Ort: Only the main cone and the vent points were taken directly from Sayre and Ort to be included as features in this map.

**NOTES:** Any observations or questions about the feature.

**ACCURACY:**

  Good: To the best of the author's knowledge, the feature is correctly located and identified.  
  Boundaries Approximate: Due to the nature of the feature the boundary cannot be precisely mapped.  
  Type needs to be checked: The author is unsure if the feature is identified correctly.  
  Boundaries need to be checked: The author is unsure if the feature is correctly mapped.  
  Type and Boundaries need to be checked: the author is unsure of type and mapping.

**APPROX_SIZE:** For point features, the approximate size of the feature, in square meters unless otherwise noted. This attribute is found only in the point feature class.

**SORT_NO:** This is the number assigned by Sayre and Ort to the lava flow unit that the feature is located in; it does not reflect the sequence of features within the different lava flows or the boca.
**transp**: this was an attribute created solely for the purpose of being able to represent multiple overlapping polygons by changing the transparency of the symbols. This attribute is found only in the polygon feature class.

### Summary of Geologic Features

**Table 1: Summary of Geologic Features Found**

<table>
<thead>
<tr>
<th>Feature Type</th>
<th>Number Found</th>
<th>Length (in feet)/ Size (in acres)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Point features:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cave</td>
<td>3</td>
<td>N/A</td>
</tr>
<tr>
<td>Squeeze Up</td>
<td>23</td>
<td>N/A</td>
</tr>
<tr>
<td>Tumulus</td>
<td>18</td>
<td>N/A</td>
</tr>
<tr>
<td>Vent</td>
<td>4</td>
<td>N/A</td>
</tr>
<tr>
<td><strong>Line features (in feet):</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lava Cascade</td>
<td>16</td>
<td>2667</td>
</tr>
<tr>
<td>Lava Ridges</td>
<td>18</td>
<td>4160</td>
</tr>
<tr>
<td><strong>Polygon features (in acres):</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boca Rampart</td>
<td>2</td>
<td>30</td>
</tr>
<tr>
<td>Collapsed Lava Tube</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>Lava Lake</td>
<td>19</td>
<td>12</td>
</tr>
<tr>
<td>Levee</td>
<td>15</td>
<td>40</td>
</tr>
<tr>
<td>Main Cone</td>
<td>1</td>
<td>450</td>
</tr>
<tr>
<td>Pooled Lava Flow</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Pushup</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Rafted Cinder Cone</td>
<td>2</td>
<td>42</td>
</tr>
<tr>
<td>Spatter Deposit</td>
<td>24</td>
<td>12</td>
</tr>
<tr>
<td>Spatter Flow</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Vent</td>
<td>3</td>
<td>39</td>
</tr>
</tbody>
</table>
Table 2: Total Area and Within Park Area of Lava Flow Series

<table>
<thead>
<tr>
<th>Flow</th>
<th>Total Area (Acres)</th>
<th>Within Park Area (Acres)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main Cone</td>
<td>450</td>
<td>442</td>
</tr>
<tr>
<td>Boca</td>
<td>215</td>
<td>144</td>
</tr>
<tr>
<td>First Lava Flow</td>
<td>540</td>
<td>53</td>
</tr>
<tr>
<td>Second Lava Flow</td>
<td>1,918</td>
<td>91</td>
</tr>
<tr>
<td>Third Lava Flow</td>
<td>3,529</td>
<td>29</td>
</tr>
<tr>
<td>Fourth Lava Flow</td>
<td>3,765</td>
<td>144</td>
</tr>
<tr>
<td>Total</td>
<td>10,418</td>
<td>790</td>
</tr>
</tbody>
</table>

**Conclusion**

A total of 157 geologic features were collected and entered into a geodatabase as part of this geologic survey of Capulin Volcano National Monument. These features were mainly based on field data collection, but were also checked against the orthophoto and USGS topographic quarter map. Further work needs to be done to ensure the accuracy of the map, included having the data checked by a geologist and GIS staff. The work done here also revealed the inaccurate lava flow map in the park brochure that needs to be replaced with the more accurate redigitized lava flow map.

**Contacts**

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Lava Flow Series and Vent Map

Sayre and Ort (1999) map included a lava flow series map which displayed the extent of the following features and flow events. This map was generalized by the GRI source map author, Rebecca Richman. These features are listed chronologically from youngest to oldest.

- Baby Capulin
- Mud Hill
- Fourth Lava Flow
- Third Lava Flow
- Second Lava Flow
- First Lava Flow
- Boca
- Main Cone

No additional information was provided, however, users should refer to the Sayre and Ort (1999) publication for additional information.

** See the GRI Source Map Citation section for the complete citation.**
GRI Digital Data Credits

This document was developed and completed by Stephanie O'Meara (Colorado State University) for the NPS Geologic Resources Division (GRD) Geologic Resources Inventory (GRI) Program.

The information contained here was compiled to accompany the digital geologic-GIS maps and other digital data for Capulin Volcano National Monument, New Mexico (CAVO) developed by Rebecca Richman (SCA Geology and Interpretation Intern) and converted to the GRI Geology-GIS Geodatabase Data Model by Stephanie O'Meara.

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