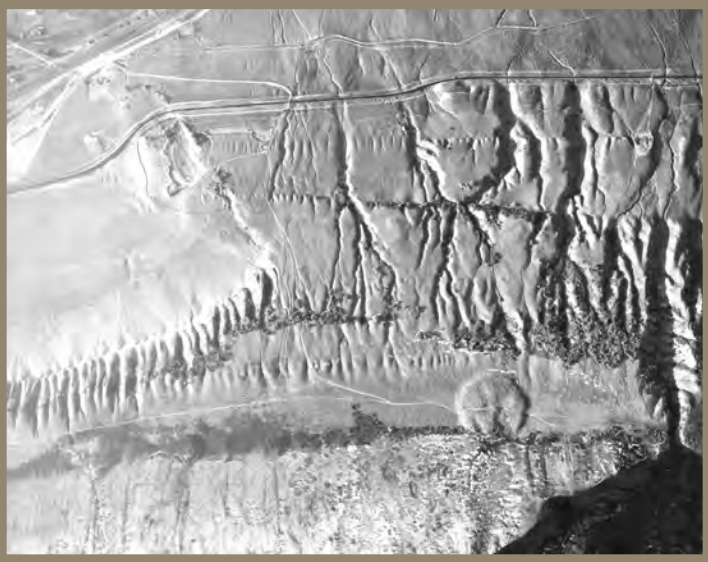
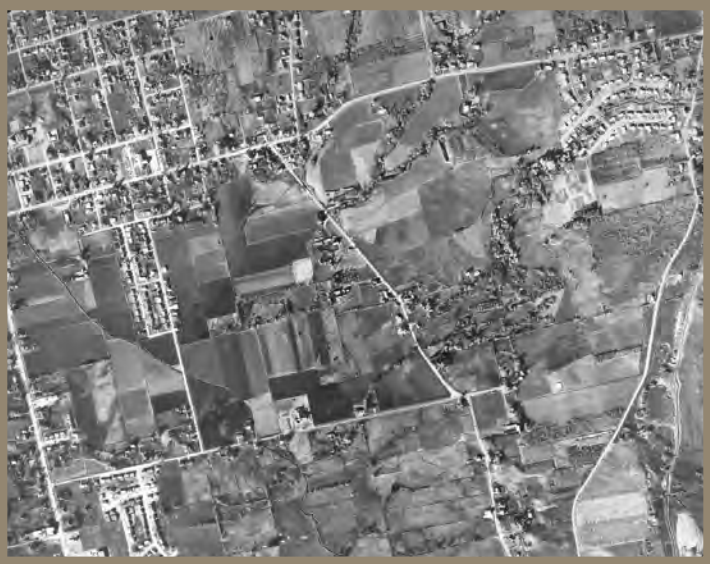
COMPILATION OF 1970s WOODWARD-LUNDGREN & ASSOCIATES WASATCH FAULT INVESTIGATION REPORTS AND OBLIQUE AERIAL PHOTOGRAPHY,

WASATCH FRONT AND CACHE VALLEY, UTAH AND IDAHO

by Steve D. Bowman, Keith Beisner, and Corey Unger





OPEN-FILE REPORT 548
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STATE OF UTAH
Jon Huntsman, Jr., Governor

DEPARTMENT OF NATURAL RESOURCES
Michael Styler, Executive Director

UTAH GEOLOGICAL SURVEY
Richard G. Allis, Director

PUBLICATIONS
contact
Natural Resources Map & Bookstore
1594 W. North Temple
telephone: 801-537-3320
toll-free: 1-888-UTAH MAP
Web site: mapstore.utah.gov
email: geostore@utah.gov

UTAH GEOLOGICAL SURVEY
contact
1594 W. North Temple, Suite 3110
Salt Lake City, UT 84114
telephone: 801-537-3300
Web site: geology.utah.gov

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INTRODUCTION

This compilation of the Wasatch fault, earthquake fault investigation and evaluation reports includes three separate reports, 47 fault maps, and 1326 scanned oblique aerial photographs (frames) that were part of the project. The Wasatch fault investigation and evaluation project was performed under contract by Woodward-Lundgren & Associates of Oakland, California, between 1970 and 1974, for the Utah Geological and Mineralogical Survey (now the Utah Geological Survey) and the U.S. Geological Survey to identify surface fault rupture hazard areas along the Wasatch fault and in Cache Valley.

This compilation covers the Wasatch Front and Cache Valley from approximately Malad City, Idaho, south to Fayette, Utah. The section in Utah includes parts of Box Elder, Cache, Weber, Davis, Salt Lake, Utah, Juab, and Sanpete Counties. The section in Idaho includes parts of Franklin and Oneida Counties. The accompanying scanned oblique aerial photographs will be useful for professionals involved with paleoseismology investigations; geologic, geotechnical, and environmental assessment and investigation projects; land-use planning; governmental agencies; and the general public and others as an historical archive. Oblique aerial photography was used to highlight certain topographic features, such as fault scarps and traces, for mapping purposes.

REPORTS

This compilation includes the three reports on the Wasatch fault project prepared for the Utah Geological Survey and the U.S. Geological Survey:

- Cluff, L., Brogan, G., and Glass, C., 1970, Wasatch fault, northern portion, earthquake fault investigation & evaluation, a guide to land use planning: unpublished consultant's report for the Utah Geological and Mineralogical Survey, variously paginated.
- Cluff, L., Brogan, G., and Glass, C., 1973, Wasatch fault, southern portion, earthquake fault investigation & evaluation, a guide to land use planning: unpublished consultant's report for the Utah Geological and Mineralogical Survey, variously paginated.
- Cluff, L., Glass, C., and Brogan, G., 1974, Investigation and evaluation of the Wasatch fault north of Brigham City and Cache Valley faults, Utah and Idaho; a guide to land-use planning with recommendations for seismic safety: unpublished consultant's report for the U.S. Geological Survey, variously paginated.

The northern portion report covers the Wasatch Front from approximately Brigham City, Utah, south to Draper and Bluffdale, Utah (Traverse Mountain area). The southern portion report covers the Wasatch Front from approximately Draper, Utah (Traverse Mountain area), south to Fayette, Utah. The north of Brigham City and Cache Valley report covers the Wasatch Front from approximately Malad City, Idaho, south to Brigham City, and Cache Valley from approximately Preston and Oxford, Idaho, south to Liberty, Utah.

The three reports, available only in paper form, were scanned on a Canon Color imageRUNNER C5180 multifunction copier, using either an 8-bit color or grayscale color space at a resolution of 300 dots per inch (dpi). The resultant scans were saved directly in Adobe PDF format. After scanning, each report PDF file was converted to a searchable text PDF format using Adobe Acrobat 8.1 and optical character recognition (OCR) features.

In addition, 47 fault maps and an accompanying index map were included in the Wasatch fault project, based on U.S. Geological Survey 7.5-minute topographic maps. The fault maps were scanned on a Contex Chroma HS 42 scanner, using an 8-bit grayscale color space at a resolution of 400 dpi (63.5 microns). The index map and cover were scanned on an Epson 1640XL scanner, using an 8-bit grayscale color space at a resolution of 400 dpi (63.5 microns). The resultant images were saved in TIFF format with LZW compression and in Adobe PDF format. Some image enhancement was performed on each fault map, index map, and cover. However, due to the generally poor quality of the available original maps, some areas of the scanned maps may not be legible. The scanned fault maps may be located on DVD #9 in the \AutoPlay\Docs\Maps directory by topographic quadrangle map name.

AERIAL PHOTOGRAPH SCANNING AND INDEXING

This compilation also includes 1326 oblique (low-sun angle) aerial photographs used as part of the Wasatch fault project. Of the com-

plete set, 567 frames were scanned from paper photograph prints and 760 frames were scanned from the original film.

The paper photograph frames were scanned on an Epson 1640XL scanner, using an 8-bit grayscale color space at a resolution of 600 dpi (42 microns) with unsharp mask enhancement. The resultant image scans were saved in TIFF format with LZW compression. Each TIFF image file was sharpened once using Paint Shop Pro (PSP) version 8 to reduce printing and scanning artifices.

The film frames were scanned by Olympus Aerial Surveys, Inc. of Salt Lake City, Utah, from the original project film rolls using a Vexcel 4000 scanner. The frames were scanned using an 8-bit grayscale color space at a resolution of 600 dpi (42 microns). The resultant image scans were saved in TIFF format with LZW compression.

As an index map is not available for the Wasatch fault compilation aerial photographs, the center point of each image scan was determined using a grid in Adobe Photoshop CS. This center point location was then compared to modern Google Earth imagery to determine approximate coordinates in the simple cylindrical (Plate Carree or latitude/longitude) projection, WGS84 datum. These center point coordinates were then used to create index maps for each report as a Google Earth KMZ file and as an Environmental Systems Research Institute (ESRI) shapefile (SHP) for use in GIS software. Due to the lack of an original index map and the variable numbering system used, it is not known if any frames are missing from this compilation.

DIGITAL FILES

Compressed keyhole markup language (KMZ) files were developed in Google Earth version 4.3 with photograph center points indicated as placemarks. Each placemark contains an embedded thumbnail (reduced resolution) image of the corresponding image frame for reference and ease in locating aerial photograph frames. The latest version of Google Earth may be downloaded from: http://earth.google.com.

To view the photograph center point placemarks easily, we recommend turning off unneeded layers in Google Earth by unchecking selection boxes next to the Gallery, Traffic, Weather, and Places of Interest layers in the Layers pane. Other layers may also be turned off; however, at a minimum, the Roads, Borders and Labels, and Terrain layers should be checked (turned on) for an adequate base map to be visible. The Layers pane is along the left side of the Google Earth window, below the Search and Places panes. Thumbnail images of the frames may be viewed by clicking once on either the red bulls-eye placemark symbol on the map or on the frame number in the Places frame. Double clicking on the frame number in the Places pane will zoom to the selected frame center point location.

Shapefiles were developed in ESRI ArcGIS 9.3 software, utilizing the point geometry type and the Universal Transverse Mercator (UTM), Zone 12 North, NAD83 coordinate system. The shapefiles contain an attribute table with frame information where known, including approximate frame center point coordinates, scan filename, segment number, frame number, film type, exposure (acquisition) date and time, image scale, scanner model, and scan resolution. Additional information about the frames, such as camera and film specifications, is not available. The shapefiles may be located on the \AutoPlay\Docs\Shapefiles directory of the first DVD.

For users without ArcGIS or other GIS software, the shapefile may be viewed using ESRI's ArcExplorer software available from: http://www.esri.com/software/arcgis/explorer/index.html.

A complete index map for each report is included on the first DVD as plates 1A, 1B, 2A, 2B, 3A, and 3B in Adobe PDF format. The base map utilizes U.S. Department of Agriculture (USDA) 2006 National Agriculture Imagery Program (NAIP) statewide (Utah) and 2004 NAIP statewide (Idaho) orthophotography for easy reference to current cultural features. Quaternary faults shown on the index maps are based on the U.S. Geological Survey Quaternary Fault and Fold Database of the United States (USGS and others, 2006).

PDF files may be viewed using the free Adobe Reader software. The latest version of the software may be downloaded from: http://www.adobe.com/products/acrobat/readstep2.html. We recommend that Adobe Reader version 9 or later should be used to view the index maps for enabling geospatial features.

Once individual frames are identified from the indexes, the corresponding high-resolution TIFF files may be located on the \AutoPlay\Docs\Images directory of each DVD. Due to the number of scanned frames and file size requirements, the TIFF files span eight DVDs, separated by directories of roll numbers. The first number of the frame filename designates the roll number. A catalog of roll, segment, and frame numbers for each DVD is shown in table 1.

LIMITATIONS

Due to the age of the aerial photograph prints, a few of the prints contain various markings from previous use. These markings may include alignment marks and lines, named geographic features, fault traces, and other features. None of these markings has been verified for accuracy in location and/or classification. As a result, these markings should not be relied upon for any purpose.

Since the aerial photograph frame-center points are estimated, some undetermined positional error exists between the frame center points and actual ground locations. Due to the use of low-sun angle photography, some of the frames contain significant areas of shadowing in mountainous regions.

Table 1. *Catalog of aerial photograph frames on compilation DVDs.*

DVD Disc Number	Roll	Segment	Frame Numbers
1	1	1	156 – 166
		2A	130 – 139
		2B	140 – 147
		2C	148 – 155
		4	122 – 129
		5	095 – 105
		6	035 – 094
		9	019 – 034
		10	001 – 013
2		10	014 – 018
		11	106 – 121
		13A	167 – 191
		13B	192 – 220
		Unknown	11 – 12
	2	1	073 – 082
		5	140 – 160
		8B	192 – 199
		9	177 – 191
		10	161 – 176
		15	200 – 215
		Unknown	002 – 015
3		Unknown	016 – 175
4		Unknown	176 – 189
	3	2A	009 – 038, 255 – 256
		13A	045 – 083
		A	002 – 093
5		A	094 – 095
		B	002 – 062
	4	1	001 – 011
		2	012 – 021
		3	022 – 047
		4	048 – 052
		5	053 – 062
		6	063 – 071
		7	072 – 079
		8	080 – 116
6	4	8	117 – 138
		9	139 – 152
		10	153 – 204
		11	205 – 213
		12	214 – 223
		13	224 – 252
		14	255 – 259
	5	1	001 – 017
		2	028 – 040
7		3	041 – 045
		4	046 – 061
		5	067 – 087
		6	091 – 103
		7	109 – 121
		8	122 – 141
		9	142 – 150
		Unknown	088 – 090
	6	1	123 – 125
		3	142 – 146
		4	147 – 160
		5	161 – 195
		Unknown	002 – 005
8		Unknown	006 – 162
	Unknown		131 – 141

REFERENCES

U.S. Geological Survey (USGS), Utah Geological Survey (UGS), and Idaho Geological Survey (IGS), 2006, Quaternary Fault and Fold Database of the United States: Online, accessed October 2008, http://earthquake.usgs.gov/regional/qfaults/.