EXPLANATION OF MAP UNITS

Qal Alluvium (Quaternary)—Channel and flood plain deposits of gravel, silt, and sand associated with modern rivers and streams. In the Clackamas River, alluvial deposits are typically cobble gravel with clasts of basalt, andesite, and dacite and subordinate lithic and feldspathic sand. Alluvium in the channel of the Clackamas River is typically thin or absent; much of the river flows across bedrock.

Qls Landslides (Quaternary)—Slumps and rockfalls. Most large landslides occur on Troutdale Formation mudstone, but some also occur on Springer Water Formation conglomerate, probably where it is deeply weathered. Two spectacular rockfalls occur where the Clackamas River has undermined cliffs of Boring Lava overlying Springer Water Formation conglomerate and Troutdale Formation mudstone. One rockfall is located just south of the Clackamas River at Carver and involves the basalt of Outlook; the other occurs north of the Clackamas River near Hardcrabble Quarry, and involves the basalt of Hardcrabble. The slide at Hardcrabble Quarry consists of jumbled blocks of lava up to 10 m (33 ft) covering about 33 ha (90 acres). The landowner reports an extensive talus cave system within the rockfall debris.

Strath terraces (Pleistocene)—Strath terraces cut by the Clackamas River into bedrock units. The planed bedrock surfaces are typically capped by sandy cobble gravel deposits up to 9 m (30 ft) thick. The gravel is typically composed of basalt, andesite, and dacite lava with feldspathic-lithic sand matrix. Four distinct terraces are differentiated based on height above the current floodplain on a profile perpendicular to the gross modern channel trend. The four terraces probably represent four ages of terrace formation related to Pleistocene glaciation in the Cascade Range or changes in downstream base level associated with Pleistocene catastrophic flood events.

Qt4 Strath terrace 4 (Pleistocene)—Surface elevation typically 15 m (50 ft) above the modern floodplain. Scattered remnants preserved largely along the north side of the Clackamas River. Mapped as Quaternary alluvium or Quaternary terrace deposits by Trimble (1963).

Qt3 Strath terrace 3 (Pleistocene)—Surface elevation typically 24 m (80 ft) above the modern floodplain. Well preserved along both sides of the Clackamas River and up major tributaries. Underlies the broad flats near Barton and along Springer Road southeast of Carver. Trimble (1963) mapped this unit mostly as Estacada Formation of late Pleistocene age, partly as Quaternary terrace deposits.

Qt2 Strath terrace 2 (Pleistocene)—Terrace surface typically 39 to 45 m (130 to 150 ft) above modern floodplain. Terraces preserved only along the south side of the Clackamas River within the map area. Mapped by Trimble (1963) as Gresham Formation of late Pleistocene age.

Qt1 Strath terrace 1 (Pleistocene)—Oldest terrace; surface elevation approximately 52 to 58 m (170 to 190 ft) above modern floodplain. Scattered remnants occur north and south of the Clackamas River. Mapped by Trimble (1963) as Gresham Formation.

Catastrophic flood deposits (Pleistocene)—Boulder to pebble gravel; sandy gravel, sand, and silt containing high percentages of Columbia River basalt clasts and representing high-energy, subfluvial deposition during catastrophic floods caused by the repeated failure of the glacial ice dam that impounded glacial Lake Missoula (Bretz and others, 1956; Baker and Nummedal, 1978; Waits, 1985; Allen and others, 1986). Date of most recent catastrophic flood is estimated to be 15,500 to 13,000 years B.P. (Mullineaux and others, 1978; Waits, 1987). Within map area, flood sediments are subdivided into two facies listed below:

Qtf Fine-grained facies (Pleistocene)—Coarse sand to silt deposited by catastrophic floods. The finer sediments are predominantly quartz and feldspar and also contain white mica. The coarser sediments are predominantly Columbia River basalt fragments. Poorly defined beds 0.3 to 1 m (1 to 3 ft) thick are observed in outcrop. Soil development commonly introduces significant clay into the upper 2–3 m (5–10 ft) of the deposits. The fine sediments are up to 18 m (60 ft) thick and mantles slopes up to an elevation of 122 m (400 ft).

Qfc Coarse-grained facies (Pleistocene)—Pebble to boulder gravel with silt and coarse sand matrix. The coarse sediments are poorly sorted and subrounded to well-rounded and range from openwork gravel to gravel with a considerable amount of fine-grained matrix material. Clasts are largely basalt, but other lithologies may
dominate downstream from bedrock exposures. The coarse flood sediments are up to 15 m (50 ft) thick in the map area.

**Loess (Holocene to Pleistocene)**—Tan to dark-brown quartz-micaceous silt and fine sand. Loess up to 15 m (50 ft) thick drapes the northern slopes of the northernmost hills in the map area. Typically the loess is massive silt with abundant pedogenic clay and coarse sand-sized iron oxide nodules. In some exposures (e.g., Grant Butte, NW¼ sec. 17, T. 1 S., R. 3 E.), the loess consists of fine-laminated and cross-laminated sand. The loess mantles units QTvj (basalt of Jenne), QTvh (basalt of Hardscrabble), QTtv (basalt of Rodlin Road), and QTs (Springwater Formation) and is therefore late Pleistocene to Holocene in age. The age of similar deposits in the Portland Hills were estimated by Lentz (1981) as 34,000 to 700,000 years.

**Boring Lava (Pleistocene to Pliocene)**—Light-gray to gray, diktytaxitic, olivine- (less commonly plagioclase-) phryic basalt and basaltic andesite flows and associated scoria erupted from a series of local vents. Boring Lava flows typically display blocky to columnar jointing, and, if preserved, vesicular flow tops. Twelve chemically distinct Boring Lava flows or groups of flows occur in the map area (Figure 1, Table 1 on Plate 2). Contact relations are rarely observed, but channel filling is clearly common. Individual flow unit characteristics are summarized below:

**QTvu** **Undifferentiated Boring Lava (Pleistocene)**—Basalt flows of unknown chemistry. Unsampled flows are present at the surface along the eastern edge of the map and as thin layers in the subsurface in the central part of the map. Those that crop out in sec. 25, T. 1 S., R. 3 E. (Ken Lette, personal communication, 1994) probably originate from a vent located about 1 mi east of the eastern edge of the map in sec. 30, T. 1 S., R. 4 E. (Lette, 1992). The radiometric age and magnetic polarity are also unknown.

**QTvb** **Basalt of Borges Road (Pleistocene)**—Flow or flows of basalt and associated scoria restricted to the hill just north of Borges Road in sec. 29, T. 2 S., R. 3 E. Maximum thickness penetrated in water wells is at least 145 m (475 ft), but this section may be deformed. Magnetic polarity is normal; the radiometric age is 510±50 ka (personal communication, R. Duncan, Oregon State University, 1981) from the only exposure located on Wooded Hills Road near the center of sec. 28, T. 3 E., R. 1 S. The vent may be located on the west flank of the hill described above, where there is a strong positive aeromagnetic anomaly (Figure 2).

**QTvr** **Basalt of Rodlin Road (Pleistocene)**—Flow or series of flows up to 50 m (170 ft) thick covering large regions in the hills just south of Gresham. All measured outcrops have normal magnetic polarity. The radiometric age is 544±25 ka (personal communication, R. Duncan, Oregon State University, 1993) from a sample taken from a roadcut in the NW¼SW¼ sec. 22, T. 1 S., R. 3 E. A possible vent may be located at the small conical hill in the SW¼NW¼ sec. 27, T. 1 S., R. 3 E, which is associated with a strong positive aeromagnetic anomaly (Figure 2).

**QTvh** **Basalt of Hardscrabble (Pleistocene)**—Flow or series of flows forming a broad plateau south and southeast of Damascus. All measured outcrops have normal magnetic polarity. Excellent exposures in Hardscrabble Quarry (sec. 17, T. 2 S., R. 3 E.) indicate that one flow was at least 45 m (150 ft) thick. The radiometric age is 612±23 ka (personal communication, R. Duncan, Oregon State University, 1992) at Hardscrabble Quarry. One likely vent for these flows is a small conical hill in the NW¼ sec. 15, T. 2 S., R. 3 E., which is associated with a strong positive aeromagnetic anomaly (Figure 2). This basalt is chemically very similar to the basalt of Rodlin Road but can be distinguished by higher SiO₂ and lower TiO₂, MgO, and Cr (Table 1, Plate 2).

**QTvw** **Basalt of Winston Road (Pleistocene)**—Flow or flows with associated scoria located to the west and north of Damascus, up to 110 m (360 ft) thick. The radiometric age is 646±27 ka (personal communication, R. Duncan, Oregon State University, 1993) from a cut on Winston Road just east of Foster Road. All measured outcrops have normal magnetic polarity. The likely vent is located in the SW¼NE¼ sec. 28, T. 1 S., R. 3 E. A water well at this site penetrated over 30 m (100 ft) of unit QTvw scoria. The unit is associated with a moderate positive aeromagnetic anomaly (Figure 2).

**QTvt** **Basalt of Tong Road (Pleistocene)**—Flow or flows of basaltic andesite or andesite forming a small body north of the Clackamas River and west of Tong Road (secs. 8 and 18, T. 2 S., R. 3 E.). The basalt may be as much as 61 m (200 ft) thick but covers only about 60 ha (160 acres). The chemistry is significantly different from the other units (Table 1, Plate 2), with relatively high Al₂O₃ and SiO₂ and low TiO₂ and MgO. There is neither an obvious vent nor strong aeromagnetic signature.

**QTvc** **Basalt of Carver (Pleistocene)**—Basalt flows, scoria, and at least one dike form a small volcanic edifice north of the Clackamas River at Carver. The dike intrudes volcanioclastic sandstone and scoria conglomerate (unit QTvsc), which is capped by unit QTvc flows. Most exposures are too deeply weathered for radiometric dating. Samples of the dike were dated at 427±26 ka (personal communication, R. Duncan, Oregon State University, 1991). The vent for this flow was probably in the modern Clackamas River channel just upstream of Carver. A moderately strong positive magnetic anomaly is associated with this unit (Figure 2).

**QTvcs** **Volcanic sandstone and conglomerate (Pleistocene)**—Well-lithified crudely-bedded tuffaceous siltstone, sandstone, and pebble conglomerate. Restricted to the area immediately around the unit QTvc vent at Carver. Massive to well bedded; composed largely of vitric silt and sand, angular to subrounded pebbles and cobbles of scoria, basalt, and rare quartzite, and feldspatic and lithic sand with some mica.
Basalt of Jenne (Pleistocene)—Basaltic scoria and at least one flow making up the hill south of the communities of Jenne and Linneman. The flow or flows are up to 18 m (60 ft) thick. At the eastern foot of the hill in sec. 24, T. 1 S., R. 2 E., a flow directly overlies a flow of basalt of Mount Scott. The flow is normally magnetically polarized and has a radiometric age of 832±128 ka (personal communication, R. Duncan, Oregon State University, 1992). The vent is probably the bowl-shaped depression in the SE 1/4 sec. 18, T. 1 S., R. 3 E. The vent area is associated with a modest positive aeromagnetic anomaly (see Figure 2).

Basalt of Zion Hill (Pleistocene)—Flow or flows of basalt and associated scoria mantling the hills immediately north of Boring and in the subsurface along the eastern edge of Sunshine Valley. The basalt is up to 61 m (200 ft) thick. Magnetic polarity measured on samples from one poor outcrop was normal. No samples were sufficiently fresh for radiometric dating. A significant negative magnetic anomaly (see Figure 2) is associated with this basalt.

Basalt of Mount Scott (Pleistocene)—Flows of basalt and associated scoria capping hills along the western edge of the map area and probably in the subsurface throughout Pleasant Valley. The basalt is up to 78 m (260 ft) thick in the map area. Extensive flows make up an irregular plateau extending over several square miles west of the western edge of the map area, and most of the chemical analyses that define this unit come from the adjacent Gladstone quadrangle. One flow directly underlies a flow of basalt of Jenne on the eastern flank of the hill in sec. 24, T. 1 S., R. 2 E., and has a radiometric age of 711±20 ka (personal communication, R. Duncan, Oregon State University, 1992). Samples from outcrops have both normal and reversed magnetic polarity. A moderate positive aeromagnetic anomaly is associated with this unit (Figure 2). There are no obvious vents in the map area, although the presence of a volcanic bomb of this basalt recovered from the north slope of the hill in sec. 18, T. 1 S., R. 3 E., suggests a nearby vent.

Basalt of Mount Talbert (Pleistocene)—Flow or flows of basalt exposed in Rock Creek along the southwestern edge of the map area in sec. 6, T. 2 S., R. 3 E. These exposures are the eastern edge of a thin sheet that extends in the subsurface to the west for about 3 km (2 mi) into the Gladstone quadrangle. The western edge of the unit in the Gladstone quadrangle is marked by Mount Talbert, a conical hill composed of this basalt. Most of the chemical analyses that define this unit come from the adjacent Gladstone quadrangle. Most of the measured outcrops have reversed magnetic polarity. The radiometric age of the unit is 1,550±170 ka (personal communication, R. Conrey, Washington State University, 1993) from a sample taken from a roadcut in SW 1/4 NW 1/4 sec. 11, T. 2 S., R. 2 E. (Gladstone quadrangle). The unit has no clear aeromagnetic signature. Mount Talbert is the likely vent.

Basalt of Powell Butte (Pleistocene)—Flow or flows of basalt, present only in the subsurface in the northeast corner of the map area. The unit also mantles the northwest slopes of Powell Butte in the adjacent Gladstone quadrangle. All of the chemical analyses that define this unit come from the adjacent Gladstone quadrangle, where samples from the only measurable outcrop have reversed magnetic polarity.

Basalt of Outlook (Pliocene)—A flow or series of flows up to 60 m (200 ft) thick that underlie a broad plateau south of the Clackamas River and west of Carver in the adjacent Gladstone and Oregon City quadrangles. This basalt is exposed only in the extreme southwestern corner of the map, and most of the chemical analyses that define it come from the adjacent Gladstone quadrangle. The radiometric age of 3,146±62 ka (personal communication, R. Duncan, Oregon State University, 1993) comes from a sample taken from the cliff immediately south of Bakers Bridge at Carver. All measured outcrops of the unit had reversed magnetic polarity. A likely vent for these flows is the hill just south of the community of Outlook, about 1.6 km (1 mi) southwest of the southwest corner of the map area.

Springwater Formation (Pleistocene to Pliocene)?—Fluvial conglomerate, volcanioclastic sandstone, siltstone, and debris flows derived from the Cascade Range. The conglomerate is moderately indurated and typically consists of well-rounded pebbles, cobbles, and boulders of basalt, andesite, and dacite with rare exotic metamorphic and plutonic rocks. The sand and silt conglomerate matrix contains varying amounts of feldspathic and volcanic lithic and vitric sediment. The conglomerate is commonly massive and profoundly weathered. Weathered conglomerates are strongly varicolored in reds, browns, gray-greens, and oranges. Fresh material is more typically gray and brown. Debris flows consist of angular to rounded clasts of basalt, andesite and dacite lava, scoria, and pumice in a matrix of clay, ash, and sand. Sandstone ranges from fine to coarse and is composed of volcanic lithic, vitric, and feldspathic sand, rarely micaceous. Siltstones and mudstones consist of quartzofeldspathic silt, ash, and clay.

The basal contact is probably conformable with the underlying Troutdale Formation and may be gradational. South of the Clackamas River, the top of the Springwater Formation appears to be part of a deeply weathered bajada surface that is well developed to the south and east of the map area and rises eastward to the foothills of the Cascade Range. This surface was originally noted by Trimble (1963). In most of the map area north and west of Noyer Creek and Highway 212, the Springwater surface is not obvious, either because it is deformed or was never developed. Boring Lava commonly overlies or is interbedded with Springwater Formation rocks. Includes rocks mapped by Trimble (1963) as Gresham, Troutdale, and Walters Hill Formations.

The Springwater Formation is predominantly conglomerate, but locally the sandstone and siltstone units are significant. Exposure in the map area is typically not good enough to map the conglomerate and sandstone-siltstone facies as separate units; instead a pattern is applied in areas where there is significant sandstone and siltstone.
Troutdale Formation (Pliocene to Miocene)—Moderately to poorly indurated mudstone, siltstone, sandstone, and conglomerate. This unit includes coarse- and fine-grained fluvial sedimentary rocks with varied provenance, including sediments with exotic origins—presumably carried by the ancestral Columbia River and sediments of local origin. Part of the Troutdale Formation was shown by Tolan and Beeson (1984) to be Miocene to Pliocene in age in the Columbia River Gorge east of the map area. The age of the unit in the map area is poorly constrained. The stratigraphic and facies relationships between these lithologies are poorly understood, so for the purpose of this map, the following purely lithologic units are mapped:

Ttg  Troutdale Formation conglomerate (Pliocene to Miocene)—Massive pebble and cobble conglomerate composed largely of Columbia River Basalt Group clasts with a significant percentage of metamorphic quartzite, granitoids, and schist. Feldspathic and arkosic micaceous sand matrix and interbeds are common. This unit correlates with unit Ttug of Lote (1992). Exposed only in the North Fork Deep Creek, Noyer Creek, and as small channel fills (not shown on map) in Troutdale Formation mudstone near Carver

Tts  Troutdale Formation volcanioclastic sandstone (Pliocene to Miocene)—Massive to well-bedded volcanic-lithic and vitric sandstone with some siltstone, locally micaceous. Exposed only in the North Fork Deep Creek and Noyer Creek. Correlates with unit Ttus of Lite (1992)

Ttm  Troutdale Formation mudstone and siltstone (Pliocene to Miocene)—Mudstone and siltstone with sandstone, rare conglomerate, and water-laid tuff. Predominantly arkosic or feldspathic and micaceous, with some lithic and vitric layers. Blue-green to gray fresh, oxidizing gray-green to brown. Typically thin bedded or laminated in siltstones, sandstone, and tuffs. Claystone is typically massive or pervasively cut by anastomosing slickensided shear surfaces. Organic material, wood, and logs are locally common. This unit was mapped by Trimble (1963) as the lacustrine Sandy River Mudstone, but ripple, channel, and trough cross bedding are common, indicating fluvial origin. Correlates with unit Ttd of Lite (1992)

Tcr  Columbia River Basalt Group (middle Miocene)—Miocene tholeiitic flood-basalt flows that were erupted from long linear fissure systems in northeastern Oregon, eastern Washington, and western Idaho from approximately 17 to 6 Ma (Swanson and others, 1979; Hooper, 1982). Formally divided into five formations (Swanson and others, 1979) and a host of mappable members and units (Swanson and others, 1979; Beeson and others, 1985; Reidel and others, 1989); in other areas within the Damascus quadrangle the Columbia River basalt is not exposed and is known only from deep borings. Samples from a well near Damascus were identified [personal communication, Marvin Beeson, Portland State University, 1994] as basalt of Sand Hollow from the Frenchman Springs Member of the middle Miocene Wanapum Basalt
Figure 1.
Geochemical sample location map. Heavy lines are major arteries. Dotted line is Damascus quadrangle border.
Figure 2.
Aeromagnetic map of the Damascus quadrangle. Interpolated total field data from Snyder and others, 1993.
STRUCTURE

The structure of the Damascus quadrangle is complex, and natural exposures of contact relations, faults, folds, or even bedding are rare. There are few distinctive lithologies in any of the sedimentary units. Therefore, the structure is best understood by analysis of water-well records (Figure 3). The various Boring Lava flows and, to a lesser extent, major sedimentary units, serve as markers. Topography and rare fault or bedding exposures fill out the picture.

The quadrangle can be roughly divided into three distinct structural domains: a southern domain south of the Clackamas River, a central domain between the Clackamas River and Johnson Creek (covering the major portion of the map), and a northern domain north of Johnson Creek.

Southern domain

South of the Clackamas River and onto the adjacent Redlands quadrangle, the structure consists of gently northward-dipping Springwater and Troutdale Formation rocks (George Priest, personal communication, 1985). Boring Lava is essentially absent, and the topography is dominated by the Springwater surface, which is incised by the strath terraces.

Central domain

Between the Clackamas River and Johnson Creek, the topography is dominated by the Boring Hills, conical or elongated hills that typically rise 105 to 210 m (350 to 700 ft) above the surrounding plateau, which may be a remnant of the Springwater surface. Structurally, most of the Boring Hills are either doubly plunging folds, fault-bounded folds, or fault blocks (see cross sections). One notable exception is the hill in sec. 18, T. 1 S., R. 3 E., which is a small cinder cone associated with basalt of Jemene. Folds are suggested by topography and bedding attitude in some instances (secs. 35 and 36, T. 2 S., R. 3 E., Walters Hill) or topography and outcrop pattern (secs. 22 and 27, T. 2 S., R. 3 E.). Fault-bounded blocks are defined by offset contacts and in some cases (southwest of Rodlin Road in sec. 21, T. 1 S., R. 3 E.) by steeply dipping to overturned bedding. Few of the faults in the central structural domain can be traced more than a few kilometers, and there are few data to constrain fault dips. Strike-slip motion on several of the faults is suggested by the changing sense of dip-slip. The only fault plane exposed (sec. 12, T. 2 S., R. 2 E., in Rock Creek) dips 60° NE, with rare horizontal slickensides and no evidence for sense of slip. The overall pattern is a network of northeast- and northwest-trending faults that bound the uplifted or folded hills. This pattern of fault-bounded rhombic domains suggests strike-slip or oblique slip on northwest- or northeast-trending faults. This style of faulting is consistent with interpretations of the Portland Basin as an area of right-lateral strike-slip faulting (Tolan and Beeson, 1984).

Boring Lava flows or vents are almost exclusively associated with the folded and faulted hills, and few of the hills are volcanic features. Most of the hills consist largely of sedimentary rock, with the lava typically located on the flanks. It is likely that the lava was erupted from vents localized by faulting.

Northern domain

North of Johnson Creek, the topography consists of a broad, relatively level plain at an elevation of 90 to 105 m (300 to 350 ft) covered with catastrophic flood gravel. Beneath the flood gravel, the rocks consist of Springwater and/or Troutdale conglomerate with rare interbedded Boring Lava flows. The plateau is broken by rare hills like Grant Butte or Rocky Butte and Kelly Butte (to the north and west on the adjacent Mount Tabor and Gladstone quadrangles). The structure of the plateau is obscured by the gravel cover. The presence of a series of northeast-southwest faults along Johnson Creek suggests that the northern domain hills may be analogous to the summits of the central domain hills protruding through the gravel cover.

Age of deformation

The youngest deformed rocks in the area are the various Boring Lava and associated Springwater Formation sedimentary rocks. This places the time of faulting as late as late Pleistocene. A fault trench was excavated in fine-grained catastrophic flood sediments in the SE1/4 sec. 12, T. 2 S., R. 2 E., by the Oregon Department of Geology and Mineral Industries, Oregon Department of Transportation, and University of Oregon in 1990. The trench was sited across the suspected trace of the northeast trending fault in sec. 12, T. 2 S., R. 2 E., and revealed no conclusive evidence of young faulting, although the catastrophic flood beds were tilted 2° to 3° to the northeast and cut by numerous liquefaction dikes. Elsewhere in the quadrangle, the youngest units, loess, alluvium, strath terraces, and catastrophic flood deposits are not clearly deformed, suggesting that there has been little or no late Pleistocene or Holocene deformation.

GEOLOGIC HISTORY

The known geologic history of the Damascus quadrangle begins in the Miocene with the eruption of numerous voluminous flows of Columbia River basalt from vents in eastern Oregon and Washington (Swanson and others, 1979; Hooper, 1982). These huge flows traveled west along a broad lowland covering large parts of the Portland area and northern Willamette Valley. As the basalt eruptions waned, parts of the Portland area, including the Damascus quadrangle, began to subside, while others were uplifted, possibly as a result of right-lateral faulting (Tolan and Beeson, 1984; Beeson and others, 1989, 1991). The subsiding area, destined to become the Portland Basin, began to accumulate sediment from the ancestral Columbia River in late Miocene and Pliocene time (Trimble, 1963; Tolan and Beeson, 1984). These sediments (Troutdale Formation) consisted of floodplain deposits (unit Ttm) and channel deposits (Ttg) distinguished by the presence of exotic lithologies (metamorphic and granitic gravel and minerals). Later during the Pliocene (Tolan and Beeson, 1984), streams draining the western slope of the Cascade Range brought abundant sediment into the subsiding Portland Basin. This sediment, which was largely composed of andesite, dacite, and basalt probably interfingered with the Columbia River-derived sediment, complicated the stratigraphic and facies relations between the Troutdale and Springwater Formations.

Deposition of the Cascade-derived Springwater Formation continued into the Pleistocene, culminating locally in the development of a broad northwest-sloping bajada (Springwater surface of Trimble, 1963). At some time during the middle to late Pleistocene, faulting and associated Boring Lava eruptions occurred in the central and northern domains, possibly extending into the latest Pleistocene. In the southern domain, the late Pleistocene was dominated by incision of the Springwater surface by the Clackamas River and its tributaries. During this time, several changes in the sediment/discharge balance or base level of the Clackamas River resulted in periods of lateral planation, forming the strath terraces. This period of planation probably caused the large rockfalls at Carver and
Figure 3.
Water well location map. Fine lines are drainages, heavy lines major arteries, dashed lines cross-sections. Numbers refer to author's unpublished well database.
Hardscrabble Quarry as the river undermined Boring Lava cliffs. These events were probably associated with the late Pleistocene glaciations in the Cascades, which were probably also responsible for the accumulation of loess. At the very end of the Pleistocene, the lowest parts of the Damascus quadrangle were inundated by massive floods released from ice-dammed lakes in Montana. These floods left thick deposits of sand, silt, and gravel on the low flat parts of the quadrangle and scoured hills that stood in their path. The flood apparently overtopped Powell Butte (184 m (600 ft) above sea level) etching linear topography along bedding in the Springwater Formation.

During the Holocene, the Damascus area has been relatively quiet geologically. Minor alluvium is deposited or transported by the Clackamas River and tributaries, and slope processes such as creep and landsliding take place.

The geology of the Damascus area has a significant impact on human activities. Early residents took advantage of the good agricultural soils developed on the catastrophic flood deposits, strath terraces, and the deeply weathered Boring Lava and Springwater Formation. Mineral resources developed in the area included Boring Lava quarried at Carver and Hardscrabble, sand and gravel quarried from numerous sites in Springwater Formation, catastrophic flood sediments and strath terrace deposits, and brick clay quarried from Springwater Formation at Hogan. Large deposits of basalt and aggregate remain throughout the quadrangle; however, competing land uses may severely restrict their development. The varied geology provides unique recreation opportunities for rock climbers at Carver and Hardscrabble Quarry (always check with landowners) and boaters who can float the scenic Clackamas River. The topography born of faulting and volcanic eruptions produced striking scenery that has recently led to significant pressure to develop farm and forest land for housing. Development of both residences and a growing nursery industry is placing increasing demand on the local ground-water resources. Management and understanding of the ground water of the area will be complicated by the complex deformation.

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