# SEMINAR NASIONAL KE-3
# FAKULTAS TEKNIK GEOLOGI
# UNIVERSITAS PADJADJARAN

## "Peran Geologi dalam Pengembangan Pengelolaan Sumber Daya Alam dan Kebencanaan"

Bandung, 28 Mei 2016

Dear All,

Perkembangan ilmu geologi yang pesat sebagai ilmu murni dan aplikatif adalah sangat terasa dalam kehidupan manusia. Peranan ilmu geologi sebagai bagian dari ilmu kebumian dalam kaitan eksplorasi dan eksploitasi sumber daya alam dirasa sangat penting, karena melalui studi/penelitian nantinya akan muncul wawasan dan strategi-strategi baru dalam kaitannya pemanfaatan dan pengelolaan sumber daya alam maupun dalam penanganan kebencanaan geologi.

Maksud diadakannya kegiatan ini adalah sebagai ajang pertemuan para ahli geologi, akademisi dan praktisi di bidang geosciences untuk mempresentasikan dan berdiskusi tentang perkembangan ilmu geologi dan hal – hal yang menarik secara geologi saat ini.
Tujuan diadakannya kegitan ini untuk menghimpun dan memetakan berbagai kegiatan studi/penelitian yang telah dilakukan oleh berbagai pihak, baik oleh akademisi maupun oleh praktisi geologi dari lembaga pendidikan (Universitas, Sekolah Tinggi, Pusdiklat) serta institusi Riset (LIPI, Badan Geologi, dll.) dan swasta. Selain itu, hasil penelitian dapat dipublikasikan dalam sebuah proceeding yang dapat menambah referensi para peneliti yang akan datang.

Tema utama yang diangkat pada Seminar Nasional ke-3 adalah "Peran Geologi dalam Pengembangan Pengelolaan Sumber Daya Alam dan Kebencanaan", dengan tema-tema penelitian sebagai berikut :
1. Pengembangan Kawasan Geopark Nasional.
2. Pengembangan Sumber Daya Energi Baru dan Terbarukan.
3. Pemanfaatan dan Pengelolaan Sumber Daya Air.
4. Pemanfaatan dan Pengelolaan Sumberdaya Migas.
5. Kebencanaan Geologi.

Kata Pengantar Dekan Fakultas Teknik Geologi Universitas Padjadjaran

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Panitia Seminar Nasional ke-3

Bandung, 28 Mei 2016
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# Groundwater Flow and Its Relation to Surface Water at The Upstream Part of Progo Drainage Area

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## Abstract

Understanding of groundwater flow and its relation to surface water is important to know about hydrology condition in the research area. It needs the understanding of groundwater level and its flow pattern as well as river water level. This research conducted by geological surface mapping completed by groundwater level and surface river water measurement. Result of research shows that groundwater flows to many direction toward Progo valley, at the central part of research area. Shallow groundwater levels vary at 100 – 835 m asl, whereas river water vary at 123 – 750 m asl. The type of relation between groundwater and surface water can be influent and effluent types. These types develop at many segments of streams. In some local area it can be found the same level of surface and groundwater. The aquifers dominantly are composed of sandstone or volcanic rocks/andesite breccia of Old Andesite Formation.

**Key word :** groundwater, surface water, Progo Drainage Area, water relation

## Introduction

Groundwater potential identification is very important in recent years in relation with the occurrence of difficulties in addressing the needs of water in the dry season which exceeds four months per year. This groundwater, especially shallow groundwater, expected as an alternative to fulfill the needs of water for daily needs, agriculture and industry.

To get good understanding of groundwater potential, we need a deep understanding related to the geological characteristics somewhere. Study of the geological characteristics of a region is very important to understand the potential of groundwater in a certain basin.

Various aspects of hydrogeology has been studied by many researchers. One interesting thing to study is the groundwater potential and its relation to surface water. The shallow groundwater potential can be studied by measuring the groundwater level and river water as well as analyzing the patterns of shallow groundwater flow.

Potential groundwater can be recognized in terms of quality and quantity. The quantity of groundwater can be represented by a shallow groundwater table position. The relationship between groundwater with surface water (river water) can be assessed by looking at the position of groundwater and river water nearby. Relationships both types of water are important studied to determine the potential contamination of groundwater that may occur in the study area.

Research areas include regions of Progo Drainage Area, particularly in West Progo Hills and its surrounding area. The

area is mostly located in Kulon Progo and Sleman District, Yogyakarta Province (Figure 1).

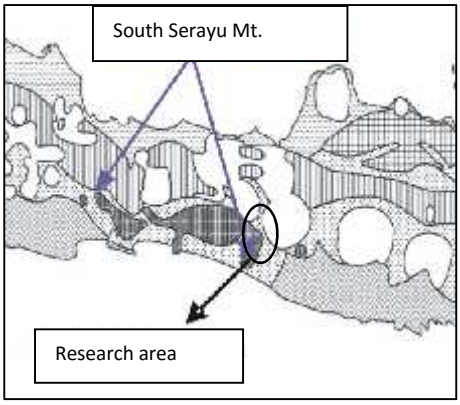



Figure 1. Research area (black ellips).

## Methodology

This research has been carried out by field geological mapping, especially focused on hydrological observation. Measurement of groundwater level has been done to dug wells, whereas surface water level has been measured on river water. Rocks description was also done to know aquifers characteristics and their potential in bearing of groundwater.

This study is limited to determine the condition of shallow groundwater. This shallow groundwater level was measured in dug wells and springs that existed at the stop sites of the observation. The stop sites were selected based on a grid which is about 2 km distance each other, on the four RBI maps of Muntilan ( northeast), Sleman (southeast), Sumberagung (southwest) and Mungkid (northwest) sheets.

## Basic Theory

Todd (1980) studied the relationship between surface water (river flow) with the groundwater table. When a ravines have direct contact with the free aquifer, the river can give (losing stream) or receive (gaining stream) of water from groundwater, depending on the relative level of the water table. Often, gaining stream can turn into a losing stream, or vice versa.

Meanwhile, Freeze and Cherry (1979) describes the effect of topography on regional flow system. In areas which have a homogeneous material geology, topography can form a complex groundwater flow system. In principle, the high area is a recharge area, while the lower area is the discharge area. Generally, on a topographical configuration, hinge line located closer to the base of the valley than hilltop.

## Groundwater Potential of Research Area

West Progo area includes in the Indonesian Hydrogeological Map, scale of 1: 250,000 Sheet VI Pekalongan (Effendi, 1985), which can be describes as follows.

1. Aquifer which flow through the spaces between the grains, local, medium productive aquifer. Aquifer is not continuous, thin and it has low transmissibility, generally have shallow groundwater table, wells debit generally less than 5 l / sec. Lithological composition in the form of young volcanic deposits Mt. Sumbing and Mt. Sindoro, consisting of andesitic lava flows, breccia and andesite lava. Permeability aquifers are moderate to high.
2. Aquifer which flow through the pore spaces inter grains, local, moderate productive aquifer. Aquifer is not continuous, thin with low transmissibility, generally have shallow groundwater table, wells debit generally less than 5 l / sec. Lithological composition in the form of young volcanic deposits Mt. Sumbing and Mt. Sindoro, consisting of andesitic lava flows, breccia and andesite lava.

Permeability aquifers are moderate to high.

3. Aquifer with flow through the pore spaces between grains, local, moderate productive aquifer. Aquifer is not continuous, thin and low transmissibility, generally have shallow groundwater table, wells debit usually less than 5 l / sec. Lithological composition in the form of swamps and lakes alluvium sediments, mainly composed by clay, generally impermeable.
4. Aquifer with interstices or porous, has low productivity and rare groundwater areas. Lithological composition in the form of intrusion rock of micro diorite, diorite, andesite, dacite and gabbro; generally have lower permeability.
5. Aquifer with interstices or porous with low productivity and rare groundwater areas. Aquifer with small productivity, locally significant. Lithological composition of a mixture of volcanic deposits (breccia, tuff, and lava) with marine sediments (sandstones, conglomerates, shale, and marl); permeability are generally low.

The eastern part or research area is composed of aquifers which come from Merapi volcanic rocks. This area is part of Yogyakarta Quaternary Basin of groundwater. Mt. Merapi Sediment Now (Young) situated on the southwestern slopes, very rich in loose sand (laharic sediment), generally has not been diagenetic yet. These deposits form the free aquifer, with a thickness of between 10-50 m, and the depth of groundwater level between 5-20 m from the surface (Kusumayudha, 2002). These aquifers are potential for providing shallow groundwater.

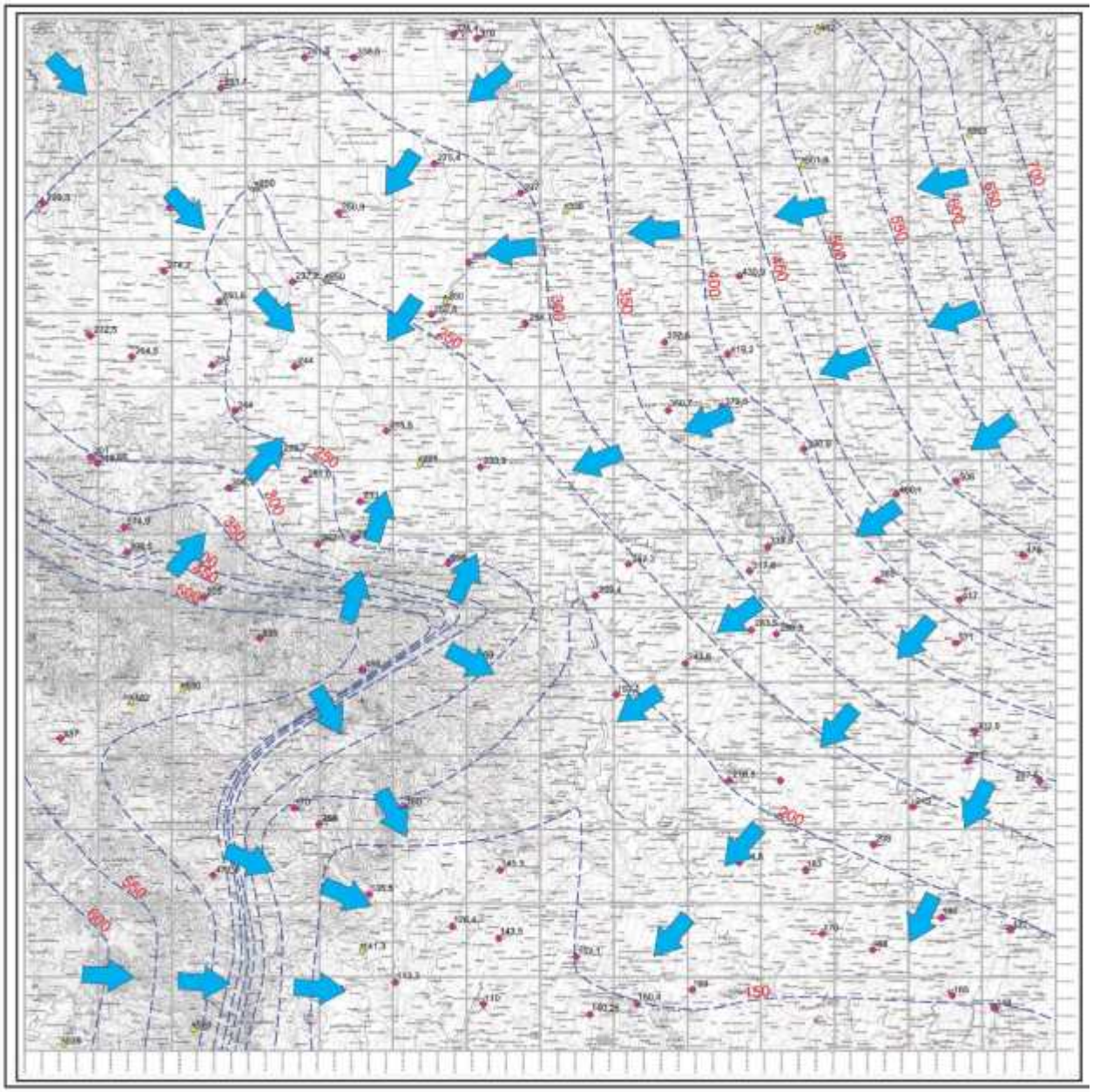
**Surface and Groundwater Level**

Shallow groundwater level measured in the field showed variable level depth, range in 0 – 20 m. The zero depth usually represent spring, such as at Tegalsari, Ngargosari (no. 139), Tulung (no.172) and Citran, Mungkid (no. 179). The deeper groundwater level usually occur in higher elevation, such as at Caban, Village, Mlati at elevation 200 m (no. 62), or Keceme, Giripurwo (no. 136) at elevation 855 m. Map of groundwater table can be looked at Figure 2, while the relation between groundwater and surface water can be shown at Figure 3.

From Figure 2 it's known that groundwater usually flows radially, toward Progo valley, almost conformably with topography of drainage area. On the other hand, it's also known in Figure 3 that rivers in some places can change their types, both of effluent or influent types.

**Petrophysic of Aquifer**

Some rock layers that can act as a shallow aquifer in the study area include andesitic breccia and sandstones (OAF). The outcrop rocks can be found at the river valleys and hillsides in the West Progo Hills. This aquifers generally have good porosity and permeability. These aquifers would support the occurrence of groundwater in the study area. Several intercalation of impermeable rocks sometimes affect the productivity of groundwater (Table 1; Figure 4).



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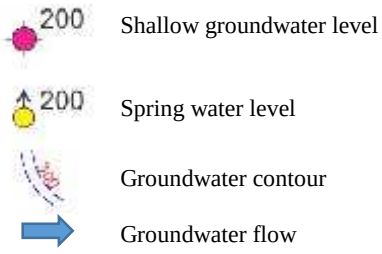


Figure 2. Map of groundwater level and flow in research area.

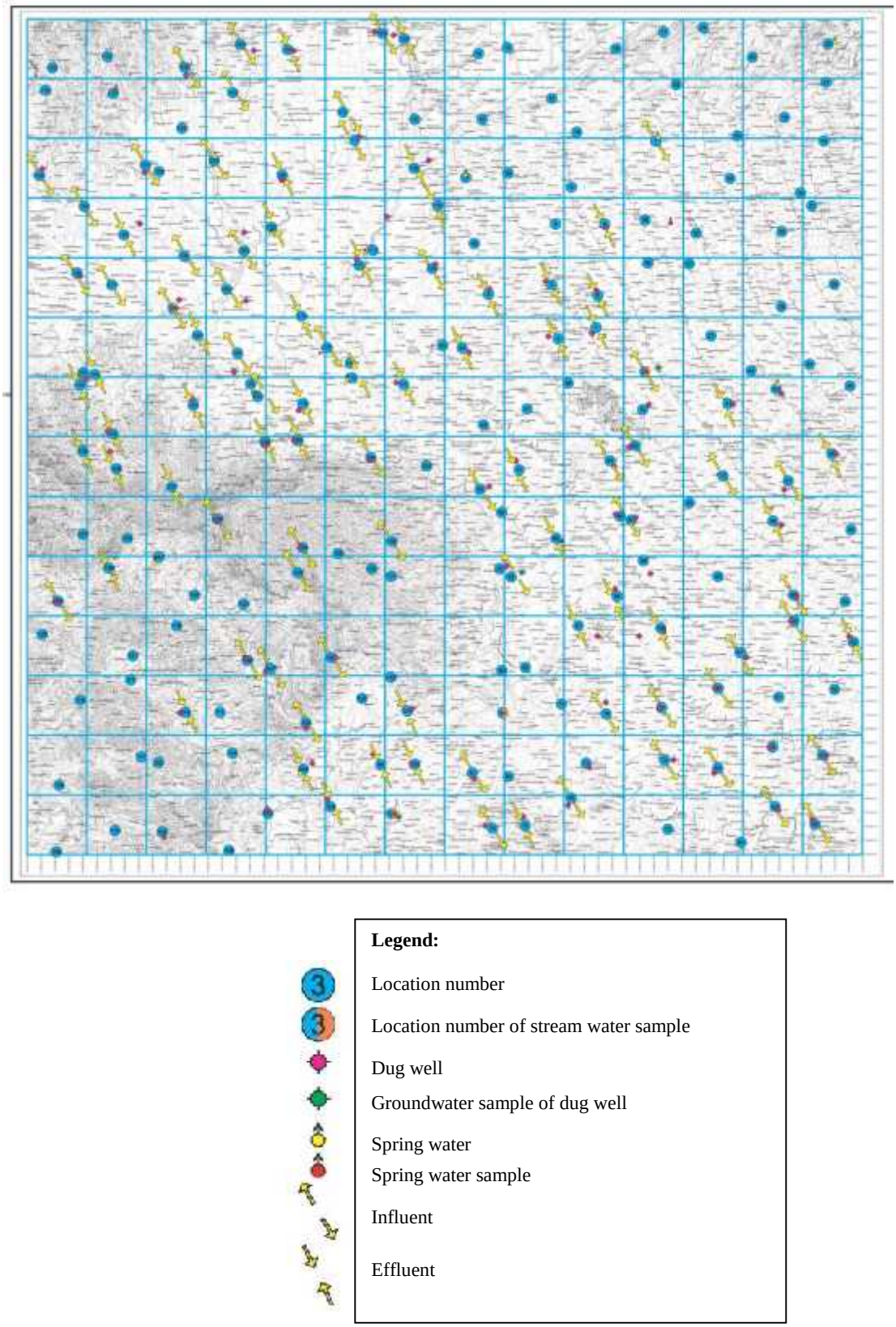


Figure 3. Relation between groundwater and surface water in studied area.

Table 1. Aquifer description in research area

| *No. sample* | *Location* | *Petrology* | *Porosity* | *Permeability* |
|---|---|---|---|---|
| I2 | Promasan, Desa Banjaroyo | Sandstone with black clay intercalation | High | Permeable |
| I3 | Gebang | Andesite breccia | Low | Impermeable |
| I4 | Tlango | Sandstone | Moderate - high | Permeable |
| I62 | Desa Gondang | Andesite with *sheeting joint* | Low | Impermeable |

Figure 4. Andesite breccia (upper), this one type of aquifer is found in the western part of Sumberagung (I62). Jointed intrusion of andesite (lower) serves as the impermeable aquitard.

## Discussion

Some segments of rivers in the study area has lower water level than the groundwater level and their vicinity, so that the rivers are effluent (receiving groundwater). On the other hand, the influent streams also develop in some segments of the river, both in the region of Muntilan and Sumberagung sheet. The various condition of the river will certainly affects to groundwater potential in the drainage area. The average groundwater of this area can be shown in Table 2.

Table 2. Average groundwater level of dug wells.

| *No* | *Sheet* | *Gw. level* |
|---|---|---|
| 1 | Mungkid | 207,92 |
| 2 | Sumberagung | 167,08 |

In the study area based on existing data, the relationship between groundwater with river water shows the relationship as influent and effluent. Influent relationship occurs in young volcanic sediment areas, where aquifers formed by loose material so that the water will run into deeper layers. While the effluent relationship occurs in areas of breccia as the aquitard. This condition is due to the influence of lithology conditions in the river area.

Table 3. Some samples of river water and groundwater level measurement.

| Loc. No. | Area | Gw. Level | River water level | Δ | Type |
|---|---|---|---|---|---|
| 1 | Ngebon Kidul | 373.5 | 371 | 2.5 | Effluent |
| 2 | Gunung Pring | 360.7 | 351 | 9.7 | Effluent |
| 3 | Karang Rejo | 377.5 | 375 | 2.5 | Effluent |
| 4 | Ngepringan | 377 | 337 | 40 | Effluent |
| 7 | Sawangan | 501.9 | 514 | -12.1 | Influent |
| 8 | Banaran | 430.9 | 423 | 7.9 | Effluent |
| 9 | Pepe | 419.2 | 414 | 5.2 | Effluent |
| 26 | Kemiren | 390.9 | 395 | -4.1 | Influent |
| 41 | Pandakan | 460.1 | 459 | 1.1 | Effluent |
| 43 | Jombang Wetan | 506 | 506 | 0 | |
| 49 | Demangan | 486.9 | 485 | 1.9 | Effluent |
| 50 | Mkatikrojan | 148 | 153 | -5 | Influent |
| 51 | Gengung | 177 | 180 | -3 | Influent |
| 53 | Krandon | 297.5 | 383 | -85.5 | Influent |
| 56 | Rejodadi | 476 | 472 | 4 | Effluent |

| | | | | | |
|---|---|---|---|---|---|
| 57 | Ganggong | 417 | 422 | -5 | Influent |
| 58 | Bangunsari | 371 | 365 | 6 | Effluent |
| 59 | Pepen | 302.5 | 303 | -0.5 | Influent |
| 60 | Pendeman | 277 | 278 | -1 | Influent |
| 62 | Caban | 180 | 180 | 0 | |
| 63 | Jaten | 165 | 172 | -7 | Influent |

**Summary**

West Progo area has some segments of river which effluent (losing stream) and influent (gaining stream). These conditions will certainly affect the groundwater level in the area, but because this area has diverse aquifers then sometimes encountered the area with relatively shallow groundwater while the other areas have deep enough level of groundwater.

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Judul : Groundwater Flow And Its Relation To Surface Water At The Upstream Part Of Progo Drainage Area

dalam kegiatan Seminar Nasional
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